THE

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THE CONSUMER AND "HIGH VOLTAGE" SUPPLY.

IT is generally acknowledged that the law, as framed by the draughtsmen of Bills and departmental Regulations, and afterwards confirmed, is liable to modification for the good of the community when experience shows that there are points overlooked and questions ignored which materially affect the issue, and that such alterations are necessary to progress. A Bill may be allowed to pass into an Act without much modification, and yet prove quite unworkable when it comes to administration. The law of the land is constantly changing, and it is well it should be so, for the end of one decade is the starting point of the new, and true progress requires an elastic yet well-considered basis upon which improvements may be grafted, and in which alterations may be made from time to time, as evidence accumulates that such are for the well-being of the public.

The Electric Lighting Act of 1882 contained a very necessary provision in Section 6, whereby the Board of Trade are authorised to make such regulations as they may think expedient for securing the safety of the public, and instead of inserting regulations for securing a regular and efficient supply of electricity in each order (as seems to have been contemplated by the draughtsmen of the Act), such latter regulations now form part of the Board of Trade's general regulations for safety and for supply. We suppose the Board of Trade could have refused to listen to outside representations as to the form of such regulations, but, fortunately, the Board thought it courteous and convenient in 1895, when it was found necessary to revise the regulations, to give to all those interested in the regulations, and who had raised objections thereto, an opportunity of stating what those objections were, and of supporting their objections by verbal arguments, so as to ensure that the Board's decision might be come to after hearing all that could be said upon the various subjects dealt with in the regulations. This very fair suggestion led to the well-known conference of November, 1895. Shortly afterwards the regulations were issued, and amongst them appeared the following in the form adopted for the metropolis [B (5)]:—"The standard pressure shall be fixed by the undertakers, and public notice of the amount of such standard pressure shall be given before the undertakers commence to supply energy to consumers, and such standard pressure shall not be altered except with the approval of the County Council, and upon such terms and conditions as the County Council may impose, and after public notice has been given, during a period of one month, of the intention of the undertakers to apply for such approval. If the County Council refuse to approve such alterations or impose any terms or conditions with which the undertakers

are dissatisfied, the undertakers may appeal to the Board of Trade, whose decision shall be final." [B (6)] "Before commencing to give a supply of energy to any consumer the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of a consumer's terminals shall not at any time be altered or departed from, except in consequence of any authorised alteration of the corresponding standard pressure. In the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be declared constant pressure. Provided that no change shall be made in the pressure of the supply to any premises which, at the date of these regulations, are supplied with energy by the undertakers, except with the consent of the consumer."

The sting of the latter regulation lies in its tail. No appeal is given from the decision of the consumer, who, for good reasons, bad reasons, or no reasons at all, may withhold his consent, and inflict—not upon himself, that would matter little, but—upon all consumers supplied by a given company or in a given district, the hardship of being subjected to fluctuations of pressure which would have to be put up with so long as the 4 per cent. limit of variation fixed by the regulations (B. 7) was not exceeded. We have spared space for a little bit of ancient history, so that those who are not as well posted in the law and legislative side of the business as they are in the technical, may grasp the points involved. These may be considered under the two heads of precedent and advantage. But before coming to them, there is another bit of less ancient history to be chronicled. Last week we recorded (p. 139) that eight London electric supply companies appeared by deputation before the Board of Trade to urge an amendment of the regulation given above, whereby the alteration of pressure was made subject to the consent of each consumer, and proposed that the change should be permitted on such terms and conditions as may be agreed upon between the undertakers and the consumer, or failing agreement, as may be settled by an arbitrator appointed by the Board of Trade.

We may now see what precedent there is for such a proposal. It is quite a common thing for consent to be dispensed with. The most important case is that of an application for a provisional order, to which the consent of the local authority is required unless the applicants request the Board of Trade to dispense with such consent, giving the reasons for such request. By Section 1 of the Act of 1888, the Boad of Trade may dispense with such consent if it is of opinion that having regard to all the circumstances of the case, such consent ought to be dispensed with. Since 1889 some 14 such cases have been dealt with under the powers given to the Board: the last and most important being the Charing Cross and Strand Corporation's City of London Order. Again, arbitration is a well-established principle in the settlement of differences on points arising under electric lighting powers. Disputes as to altering the position of pipes; obstructing the use of canals or docks; the amount of compensation for damage done; the interference with supply to other consumers by any consumer; questions between the undertakers and the Postmaster-General, owners of private streets, of sewers, or of gas or water pipes, or of electricity mains, or of subways; and many other matters, such as price of supply to public lamps, maximum power of a consumer, establishment of testing stations, are left to be settled by arbitration. The proposals, therefore, of the London companies are eminently reasonable, and are capable of being fully supported by precedent, for if so many other, and some of them much more important, questions may be left to this essentially legal and well-understood way of getting rid of difficulties, surely a consumer, who loves the old-fashioned 100 volts so well that he does not want to have it altered, is fully protected by such a modification as that suggested. It is certainly fairer to the undertakers who are tied down in every conceivable way, and yet have to give, and continue to give, a satisfactory and reliable supply of energy to all and sundry who may call for it.

This at once raises the technical question. The advantage is so great that it is almost obvious that within a year or two the higher pressure must be adopted by all undertakers. The consumer would gain by imbibing some of the arguments used so long ago as 1896 by Mr. Barnard and by Mr. Couzens in their Municipal Electrical Convention papers. The former expressed the belief that the 220-volt lamp would soon be recognised as the most useful advance that had been made in electric lighting for the previous year or two. Four years' experience has been found to fully sustain this opinion, and whatever reasons may have existed in 1895 for retaining the veto of the consumer, it cannot be safely held that there is now good excuse for leaving it in the power of individuals to inconvenience the general supply to a district. We are well aware that one or two speakers at the Institution meetings make it their business to condemn the use of 200—250 volts on every possible pretext, but they are voices in the wilderness, and on the other side we have men of the experience of Mr. Chamen, Mr. Baynes, Mr. Gibbings, and Mr. Addenbrooke—to mention but a few—who cordially endorse the higher pressure. Dr. A. B. W. Kennedy, in addressing the President of the Board of Trade, emphasised what is so often found, that the proviso in practice gave the right to any casual consumer to object. There are those who, as he said, wish to be paid whatever they choose to demand. These are they who nullify the concession granted by the Board of Trade when the limit of low pressure was raised. In the Westminster Company's district only 10 consumers absolutely refuse to change out of a total of 5,300. As the London County Council conditions of consent are onerous, and the undertakers have to bear the cost, there is every reason why a very infinitesimal number of consumers should not be allowed to prevent the change to a higher pressure being carried out. The President of the Board of Trade seemed to think that companies should propitiate people, and apparently attached great importance to the wording of notices to consumers, while he talked about the "rights of consumers." As these "rights" have been practically created by the Board of Trade, and their abrogation can be shown on solid technical grounds to be hardly hurtful at all to those who claim them, while they stand at present as an obstacle in the way of a much-needed improvement, we can only hope that the Board of Trade will seriously consider whether in the public interest it is not now time for a quinquennial revision of the regulations; at least, so far as B No. 6 is concerned.

ELECTRIC CRANES.

(*Continued from Vol. 46, page 428.*)

Our series of articles on this subject will be concluded with some remarks under the following headings:—

One-Motor *versus* Three-Motor Cranes.
Electrical Switch Gear.
Brakes.
Working of the Crane.
Usual Crane Speeds — Sizes of Motor Suitable for Different Loads—Specification of Motor Suitable for Crane Working.

One-Motor *versus* Three-Motor Cranes.

In converting existing rope or shaft-driven cranes to electrical driving, a single motor is almost always used, for it can be easily fitted with very little change to the existing gearing.

When it comes, however, to buying a new crane, it is often an open question whether to adopt the single or the three-motor type.

The single-motor crane is extremely simple so far as the electrical equipment is concerned. The motor starts up on a light load, runs only in one direction, and is controlled by a switch simple in design and not likely to give trouble in use from sparking or other causes.

The gearing and other mechanical devices are, however, somewhat complicated, which is rendered necessary by the three motions having to be each reversible and independently controlled, and being worked from a single pulley, which is driven by the motor, and which runs at a constant speed and in one direction only.

Fig. 27

The three-motor crane is simpler so far as the gearing is concerned, but more complicated as regards the electrical equipment; not only does it involve three motors in place of one motor, but these three motors have to be reversible, and this introduces difficulties which are not so easily surmounted in the switches as they are in the motors.

The difficulties met with, as explained later on, have been more or less overcome, yet reversible switches will always be more liable to give trouble, and will want more attention during working, than the simple switch for controlling the single motor.

The question of first cost of the complete electrical cranes, as seen from the following figures, points in favour of the one-motor crane, as being about 33 per cent. cheaper for the smaller sizes—say, up to 10 tons—and about 20 per cent. cheaper for larger sizes—say, up to 30 tons.

On coming, however, to still larger sizes, 50 tons and upwards, there is little to choose in price between the one and three-motor cranes. The additional cost of electrical equipment in the three-motor type is counter-balanced by the saving in the gearing.

Comparison between prices of one and three-motor Cranes.—Cranes built by Broadbent & Sons, of Huddersfield; electrical equipment by Crompton & Co., of Chelmsford.

	One-motor type.	Three-motor type.
5-ton overhead traveller, 30 feet span, complete with necessary electrical equipment	£375	£500
15-ton overhead traveller, 50 feet span, complete with necessary electrical equipment	£760	£920

So far as convenience and control in working are concerned, certain advantages come out in favour of the three-motor type.

A crane in hoisting or traversing its load should start into motion slowly, should accelerate rapidly, and should deal with the greater portion of the hoisting or traversing at full speed. It should then slow quickly and stop. A good regulation is also required over the speed of each motion.

All this is more easily attained with a motor to each motion, and the series wound motor, whose speed varies in proportion to the load, lends itself very aptly to this class of work, and is almost universally used.

Any further speed regulation required, beyond that given naturally by the motor, is easily attained by means of the starting resistance in series with the motor.

In the case of the one-motor crane, the speed of the motor is kept constant, as it is not convenient to provide for sufficient variation in the working speed to be of any material use.

The gearing being arranged for a safe working speed with full load, the light load is often worked at the same speed as the heavy load. In small cranes up to 5 tons this is no serious disadvantage, but when both light and heavy loads are dealt with, it is desirable to work the light loads at a quicker speed than the heavy ones.

This is got over to a certain extent by having a quick and a slow speed gear, but even this only gives as many speeds as there are gears provided, instead of intermediate speeds between the maximum and the minimum, as is the case with the three-motor crane.

In shops of short length there is little advantage in being able to travel the empty crane or the light loads at a quicker speed than the full load, and consequently the three-motor crane has no great advantage over the one-motor crane, so far as speed of travelling is concerned.

Again, for short spans, say, 40 feet and under, the tumbler bearings and cross shafts, rendered necessary in one-motor cranes, are not so serious a disadvantage as is the case in spans of greater width—and consequently here again the three-motor crane has not much of a pull over the one-motor crane.

Fig. 27 shows a 15-ton overhead traveller, made by Broadbent & Sons, of Huddersfield, and driven by a single Crompton compound motor.

The crane is designed for a span of 40 feet, and for a shop 150 feet in length, the hoist being 5 feet p.m., and travel 150 feet p.m.

The working of this type of crane has been so satisfactory, and the annual maintenance on it so small, that one cannot help thinking that three-motor cranes are often used, especially in small shops, where one-motor cranes would be quite as suitable, and cheaper in the first cost and maintenance.

The small amount of power wasted in the gearing after all does not represent a large item in the coal bill, provided the motor is switched off when out of use, as is usually the case.

The tendency at the present time among both crane makers and engineers in general, is to prefer the three-motor to the single-motor crane.

We are quite in agreement with this for heavy cranes or where the span is wide, and the shop a long one, say, span

exceeding 40 feet, and length of shop 150 feet, and finally where the nature of the work requires a large variation in the working speed, but to use three-motors on a small crane, or even on larger cranes, in small shops, often seems quite unnecessary.

In other words, it would not appear as if the slight additional advantages gained by using three motors, under such conditions, would warrant the increased first cost and the additional maintenance cost of the electrical equipment.

It might be mentioned in passing that a great many cranes are now being built for four motors in place of three, two separate winding drums being provided, the one to deal with the heavy loads, the other with the lighter loads; although four motors are fixed, only three controllers or switches are usually used, the two hoisting motors never being in use at the same time.

The two winding drums enable the best speeds to be obtained for the light and heavy loads.

In deciding whether to adopt the three or the one-motor crane, each case must be gone into on its own merits, the size of shop, nature of work to be handled, speed of working required, &c., all being taken into consideration, and in our opinion a great many cases will be found where the one-motor crane will meet all the requirements.

Electrical Switch Gear.

The starting switch for controlling a single-motor crane is extremely simple, and not likely to give any trouble in use.

The one used on the crane shown in fig. 27 possesses the advantage that, being fitted with a spring flipper between every successive contact, no sparking can possibly take place on the contacts themselves.

It is well known that, although the largest spark takes place on switching off from the last contact, an appreciable spark takes place in passing from one contact to another, which, in time, is sure to prevent the smooth working of the switch.

This is obviated in the switch referred to by transferring the sparks from the contacts to the "flipper," which can at any time be easily renewed.

The switch can be fixed in any convenient position in the operator's cabin, or, if desired, can be fixed above, but worked from below, by means of a rope or chain passing round a suitable grooved pulley, fixed on the switch spindle.

The switch is only used for starting and stopping the motor, and not for reversing, as the different motions are controlled by their separate levers, which actuate the different clutches or belts.

Provided the switch, or chain operating the switch, is within easy reach of the operator, it is unnecessary to have an additional quick-break main switch, for, in case of emergency, this type of switch can be quickly taken off.

The electrical equipment of the operator's cabin, on a single-motor crane, may conveniently consist of the following :—

(*a*) One motor-starting switch.
(*b*) Two single-pole fuses.
(*c*) One ammeter.
(*d*) One wall socket for inserting plug for portable hand lamp.

Extra.—One rheostat for working in series with shunt of motor, if any speed regulation is deemed necessary.

The switch gear for regulating three-motor cranes is not so simple. There is still a good deal of difference in opinion as to whether it is better to use the ordinary wire resistance with metal starting switch, or to use a switch of the liquid type.

Whilst, on the one hand, the metal starting switch is cleaner, and does not require so much attention when in use, yet there is always a good deal of sparking going on, which gradually destroys the contacts, and consequently does not ensure a very long life to the switch.

On the other hand, the liquid switch requires frequent attention in the way of refilling with liquid, as a good deal is lost by evaporation and by being jolted out of the tanks. It is also rather unpleasant for the operator through splashing, which is difficult to prevent if the crane is started or stopped with a jerk, as is usually the case.

Finally, the liquid makes it more difficult to maintain the insulation of the cables, &c., entering the operator's cabin.

There is, however, no sparking either on starting or on reversing the motor, and consequently little deterioration is going on, and the life of these switches may be looked upon as a long one.

The attention required by the liquid switches is not a serious matter, as they are always within sight of the operator, and usually a man gives up the whole of his time to the crane, and consequently has plenty of leisure for keeping it up to the mark.

On the whole, it is probable that the liquid type of switch is the right one for these reversing motors, and we know of excellent results which have been obtained with them.

A separate switch is used for each motor, and it can be conveniently fixed on the floor of the operator's cabin, in front of the seat, with the handle standing vertically upwards, in the "off" position.

By means of a commutator on the spindle of the switch, it can be arranged so that by moving the handle in one direction the motor goes in one direction, whilst by moving it in the opposite direction the motor is reversed, as in the example illustrated on p. 59 of our last volume. These resistances are used on cranes very largely for speed regulating purposes, and they will control the speed of the motor to a nicety.

It is possible to have one large tank to take the place of the three smaller ones, but this is not desirable, as the splashing from the large tank is a good deal more serious and more difficult to prevent than the splashing from the smaller tanks.

(*To be concluded.*)

NEW ELECTRIC TRAMWAY SCHEMES FOR LONDON.

The London County Council proposes to promote a Bill in the next session of Parliament to authorise the construction of 28¼ miles of new tramways in the metropolitan area, to be laid entirely with heavy rails, for the purpose of electric traction. All the lines to be connected with the existing County Council tramways will be electrically equipped, whilst those which will be joined to the system leased to the North Metropolitan Tramways Company are initially proposed as horse lines, unless their tramways have been converted from horse to electric traction in accordance with the provisions in the company's lease. The tramway schemes have been reported upon at some length by the Highways Committee, and the necessary street widenings have been similarly dealt with in a report by the Improvements Committee. The following extracts from the report of the former may be of interest in relation to the proposed new tramways :—

Proposed new Tramways—North of the Thames.

1. Archway Tavern (existing lines) to the County Boundary; length, 3 furlongs.—This line would form the link between the Council's (northern) tramways and the light railways beyond the county boundary, for the construction of which the Middlesex Council is seeking powers. The Middlesex Council proposes to use a system of electric traction on its light railways, and we think this line should be constructed for a similar mode of traction. The cost of construction for electric traction is about £8,400; and current for working it could be obtained from the Vestry's electric light station or by arrangement with the Middlesex Council.

2. Seven Sisters Road (existing lines), *viâ* Amhurst Park to Upper Clapton Road (existing lines); length, 5 furlongs 1 chain.—This proposal was included in the Council's Tramways Bill of this year, but was withdrawn owing to the refusal of the Vestry of Hackney to assent to the construction of the tramway. In the hope that the road authorities concerned may eventually consent to the construction of the line, we have included the proposal amongst the others. No street widenings will be required; and the estimated cost of construction of the tramways, for horse traction, is £11,250.

3. Mildmay Park (existing lines) Westwards to Balls Pond Road (existing lines); length, 2 chains.—This is a short junction line, suggested by the engineer as an alternative to a proposal of the Vestry of Islington for the construction of tramways, which would involve expensive street widenings along Newington Green Road.

4. Harlesden (near the County Boundary), *via* Scrubbs Lane, Wood Lane, Shepherd's Bush Road, Brook Green Road, and Fulham Palace Road to Putney Bridge: Length, 4 miles, 7 furlongs.—This line would be very valuable from a traffic point of view, as providing

much-needed means of transit. The construction of a double line would necessitate certain street widenings, the estimated cost of which is £139,950. The Improvements Committee is prepared to recommend the Council to carry out these widenings, subject to one-third of the cost being borne by the Vestries of Fulham and Hammersmith, one-third being charged to the account of the improvement, and the remaining third to the tramways account; and with this proposal we concur. The cost of construction for electric traction is estimated at £146,250, and for horse traction at £73,050.

5. Uxbridge Road (near the railway station) *via* Richmond Road, Netherwood Road, and Westwick Gardens, to Shepherd's Bush Road: Length, 3 furlongs.—This short piece of line would form a useful adjunct to the tramways (No. 4) at Shepherd's Bush Road, of which the line would, indeed, practically form part. Some small street widenings would have to be carried out, the estimated cost of which is £8,700. In this instance the whole cost will have to be borne by the tramways account, unless the Vestry of Hammersmith can be induced to make a contribution. The cost of the construction of the line for electric traction is estimated at £11,250, and for horse traction at £5,500.

6. Brook Green Road, at its intersection with Hammersmith Broadway, *via* that thoroughfare to the London United Tramways at Glenthorne Road; length, 5 chains.—This was proposed by the engineer as a connecting link between the proposed tramways (4) and the London United Tramways. We propose that this line shall be constructed for electric traction, the estimated cost being £2,000.

7. Victoria Embankment (Blackfriars end), *via* the Embankment, Victoria Street, Buckingham Palace Road, Commercial Road, Bridge Road, and the Chelsea Embankment to near Battersea Bridge; length, 4 miles 3 furlongs.—It is suggested that this should be continued along World's End Passage to and over Putney Bridge. The road authorities whose consent would have to be obtained are the Vestries of St. Margaret and St. John, Westminster, St. George, Hanover Square, and Chelsea. The first-named Vestry is not hostile to the scheme, the Vestry of St. George has signified its approval, and no decision has yet been come to by the Vestry of Chelsea. No street widenings will be necessary in connection with this line, the estimated cost of the construction of which for electric traction is £132,000.

8. Battersea Bridge, *via* Chelsea Embankment, World's End Passage, King's Road, New King's Road, and Putney Bridge Approach, to and over Putney Bridge; length, 2 miles 1 furlong 2 chains.—This line, which is in continuation of No. 7, would involve the widening of the whole length of World's End Passage, and also widenings in King's Road and New King's Road, the cost of which is estimated at £396,410. The authorities concerned are the Vestries of Chelsea and Fulham. The Vestry of Chelsea has not yet decided whether it will contribute or not, but the Vestry of Fulham states that it does not consider that the expenditure for widenings would be of benefit to the parish. The Improvements Committee is prepared to recommend the Council to undertake the street widenings, and to pay out of improvement funds one-third of the cost, provided that the two authorities concerned will, together, contribute another third, the remaining third being borne by the tramways account. The cost of construction for an electric system is £179,000.

9. Hampstead Road (tramways terminus), across Euston Road, and along Tottenham Court Road to Oxford Street; length, 5 furlongs 4 chains.—The Vestry of St. Pancras and the St. Giles District Board have both refused their consent. The cost of construction for horse traction is estimated at £10,200.

10. Theobald's Road (tramways terminus), *via* Vernon Place, Bloomsbury Square, Hart Street, across Oxford Street and along Shaftesbury Avenue to Cambridge Circus; length, 4 furlongs 7 chains.—The St. Giles District Board, through whose district parts of the tramways would be laid, has refused consent to any tramways being constructed, and the Holborn District Board has not expressed any opinion with regard to the proposal; but the line would be of such value to the public that we include it, in the hope that those bodies may be induced to assent to it. The estimate of the cost of construction for horse traction is £8,800.

11. Farringdon Road (tramway terminus), along that road to the City boundary; length, 2 furlongs 4 chains.—This was suggested by the engineer, but his proposal was that the line should extend to a point near Ludgate Circus. The City Corporation was not prepared to assent to the tramways being laid within the City area; and our proposal is therefore that the line shall stop short at the City boundary. The road is sufficiently wide for a double line of tramways, and the estimated cost of construction is £4,500.

12. Victoria Embankment, *via* Westminster Bridge to the L.C.C. tramways terminus in Westminster Bridge Road; length 3 furlongs.—The Vestry of Lambeth approves the proposal, and has expressed itself in favour of the extension of tramways over the bridges. The Council has on two or three occasions endeavoured, without success, to obtain powers to construct tramways over the bridge; but we think that a further endeavour should be made. The estimated cost of construction for electric traction is £11,250, and for horse traction £5,600. We submit in this case alternative estimates, as it is doubtful whether there is sufficient space under the carriageway of Westminster Bridge to permit of the laying of the conduit system.

13. Chelsea Bridge (north end), *via* Grosvenor Road, to a point near Lambeth Bridge; length 1 mile 4 furlongs 8 chains. This line would not, at first, be in connection with the L.C.C. tramways, although there is little doubt that it would eventually be so connected; and we think that it should be constructed for electric traction. The estimated cost of construction for electric traction is £50,000, and no street-widenings would be necessary.

Proposed new Tramways—South of the Thames.

14. York Road, Wandsworth (South London Company's lines), *vid* the new street, 50 feet wide, in course of formation between York Road and Red Lion Street, along Red Lion Street, across High Street, along South Street, Garratt Lane, and Defoe Road to High Street, Tooting (L.C.C. lines); length, 2 miles 7 furlongs 8 chains.—The Wandsworth District Board has urged that the widening of Red Lion Street should be included among those in connection with the tramway proposals, so that the new tramways may extend from York Road along the route indicated above. The Improvements Committee has agreed to the extra width, and proposes to recommend to the Council that one-third of the cost of the street widenings shall be charged to the account of the improvements, one-third be contributed by the Wandsworth District Board, and the remaining third charged to the tramway account. The estimated cost of the construction of these tramways for electric traction is £90,000.

15. St. John's Hill, near Clapham Junction Station (South London Company's lines), *vid* Strath Terrace, Bolingbroke Grove and Belle Vue Road to the Surrey Tavern, at the junction of that road and Trinity Road; length, 1 mile 3 furlongs 1 chain.—The consent of the Vestry of Battersea and of the Wandsworth District Board will be required to the tramways along portions of the route; and the Improvements Committee is prepared to recommend that, subject to these consents being given, and to the Vestry of Battersea agreeing to pay one-fourth of the cost of the street widenings in the parish, the Council shall undertake the street widenings, one-fourth of the cost being charged to the account of the improvements and the remaining half to the tramways account. The cost of construction for electric traction is estimated at £47,500.

16. Battersea Park Road (South London Company's lines), *via* Albert Road, to the foot of Albert Bridge; length, 4 furlongs 8·8 chains.—The tramways manager is of opinion that it would be of advantage to the council to have powers to make the extension to Albert Bridge when it shall have acquired the company's lines, for the purchase of which the council has decided to serve notice. The estimated cost of construction for electric traction is £18,500.

17. Camberwell Green (L.C.C. lines), *via* Denmark Hill, Champion Park, Grove Vale, Lordship Lane, and London Road to Devonshire Road near Forest Hill railway station; length, 3 miles 4 furlongs 6 chains. This was suggested by the Vestry of Camberwell, one of the road authorities concerned; the others being the Vestry of Lambeth, which approved the proposal, and the Lewisham District Board, which has refused its consent. Some extensive street-widenings would have to be effected before the tramways could be laid, and the cost of these is estimated at £155,450. Of this amount the Improvements Committee proposes that the road authorities concerned should contribute one-third, that one-third should be paid out of the funds applicable to the improvement, and that the remaining third should be charged to the tramways account. The committee is prepared to recommend the Council to carry out the street-widenings on this basis. The estimated cost of construction for electric traction is £107,000.

18. Goose Green, *via* East Dulwich Road and Peckham Rye, to the junction of Hall Road and Stuart Road, Peckham; length, 1 mile 4 chains.—The Vestry of Camberwell submitted a suggestion for the construction of tramways from Goose Green, to Inverton Road, Honor Oak, and the manager approved of this. We found, however, that the construction of a double line beyond Stuart Road would involve a considerable outlay for street-widenings; and have decided to recommend that the line shall go only as far as Stuart Road, up to which point no widening would be necessary. The estimated cost of construction for electric traction is about £31,500.

19. Southwark Street, at Hop Exchange Corner (South London Company's lines), *via* Southwark Street, Stamford Street and York Road, and across Westminster Bridge Road, thence (single line) to Lambeth Palace Road (same company's lines), and returning *via* Stangate over a proposed connection between the L.C.C. lines and the company's lines near Westminster Bridge; length, 1 mile 2 furlongs 7·7 chains. This was proposed by the St. Saviour's District Board, and is approved by the Vestry of Lambeth. The estimated cost of construction of the line for electric traction is £45,000.

20. Waterloo Road (L.C.C. Tramways terminus), along that road to a point opposite the York Hotel; length, 1 furlong 7·1 chains.—There is little doubt that the removal of the tramways terminus to a point nearer to Waterloo Bridge will be a decided advantage to the traffic, and will probably cause an increase in the number of passengers using the lines. The Vestry of Lambeth approves of this extension. The cost of construction for electric traction is estimated at £6,500.

LEGAL.

Brockie-Pell Arc Lamp Company *v.* Johnson & Phillips.

This case came before Mr. Justice Kekewich in the Chancery Division on Thursday on a motion to commit the defendants for the alleged breach of part of an order made by his Lordship on April 22nd, 1899. Mr. Warrington, Q.C., and Mr. J. C. Graham appeared for the plaintiffs in support of the motion, and Mr. Fletcher Moulton, Q.C., and Mr. A. J. Walter for the defendants.

Mr. Warrington, in opening the case for the plaintiffs, said that the notice of motion asked that the Court be moved to commit the defendants for breach of that order by selling certain lamps known by the name of Victoria lamps. The action in which the order in question was made was an action for infringement of certain patents. The order in question restrained the defendants during the continuance of the plaintiffs' letters patent from manufacturing, selling,

or exposing for sale Victoria lamps, and that the defendants were not in any other manner to infringe the said letters patent. But the order was not to apply to any Victoria lamps manufactured or sold by the defendants which bore the serial numbers mentioned in the order. The order then went on to state that all further proceedings be stayed except for carrying the order into effect. The learned counsel stated that his Lordship would see that the order was in two parts. It first restrained the defendants from manufacturing or selling, or exposing for sale, Victoria lamps, and secondly, it restrained the defendants from infringing the plaintiffs' letters patent. The present motion was not founded upon the second branch of that order. It was founded simply on the first branch, and if he (counsel) failed to satisfy his Lordship that the lamps the defendants had been selling were within the true meaning of the order Victoria lamps, then except to two of the lamps, which were admittedly Victoria lamps, the motion would fail. On the present notice of motion, he asked his Lordship for relief, and to say that certain lamps which it was admitted had been sold by the defendants were Victoria lamps. His Lordship would observe that the notice of motion referred to lamps of certain numbers. The first two of those lamps mentioned in the notice were admittedly Victoria lamps, and they were not included amongst the serial numbers mentioned in the order, and excepted in the injunction. The consequence was that on those two lamps the plaintiffs were clearly entitled to have an order to commit the defendants who had committed a breach of that order which restrained them from selling Victoria lamps with the exception of those with serial numbers mentioned in the order. The only answer on that part of the case was that the defendants had sold those two particular lamps to certain third parties before the date of the order, and had repurchased them, and sold them again. He (counsel) submitted that that was no answer, as the defendants were restrained from selling any Victoria lamps except those mentioned in the order—the exception being those with serial numbers. It was no answer for the defendants to say "we bought those two lamps in the market and sold them again." The defendants had no right to sell them again. The plaintiffs could not prevent third parties from selling the lamps, but they could prevent the defendants from selling them. The order was absolute that the defendants should not sell any Victoria lamps except those specified in the order. His Lordship would notice Nos. 16,387, 16,354 and 16,338 amongst the numbers mentioned in the notice of motion. That referred to lamps to which the defendants had applied the same serial numbers that were mentioned in the order and sold. The plaintiffs' case was that the defendants had made certain slight and immaterial changes in those lamps for the purpose of being in a position to say they were not Victoria lamps. He (Mr. Warrington) should point out to his Lordship that the changes which had been made were immaterial and trifling changes, which left the lamps substantially what they were before. The only lamp which his Lordship would be troubled with was that numbered 16,338 which hung on a frame in the Court, and it had been agreed between the parties that all the other lamps except the first two were identical with the lamp No. 16,338. No. 16,371 also bore one of the serial numbers mentioned in the order, but those were in the same position as those he had mentioned, and were sold after the 200 lamps mentioned in the order had been sold. With regard to the others, Nos. 16,839 and 16,863, were sold to a Mr. Hawkins.

Mr. Moulton: We admit the sale of all those.

Mr. Warrington: Well, all your Lordship will be troubled with is to say whether No. 16,338 was a Victoria lamp or not.

Continuing, the learned Counsel said he would just point out to his Lordship in what way 16,338 was said to differ from the Victoria lamp. The learned counsel proceeded to read affidavits in support of his case.

Mr. Dugald Clerk in his affidavit stated that he had carefully examined and compared the electric arc lamp, No. 16,338, which was typical of all the defendants' lamps, with the Victoria arc lamp. In his opinion the lamps were substantially the same. There were some trifling differences in the structure of the two lamps, but they were so trifling that they could not be said to make No. 16,338 a different lamp from the Victoria lamp.

In an affidavit of Mr. Brockie, he stated that in his opinion the lamps were in all respects substantially identical.

Mr. Walter then read the defendants' affidavits.

The defendant, Mr. Johnson, said he was in a large way of business in the manufacture of electric arc lamps and other electrical appliances. For several years past he had employed a competent manager in his arc lamp department. He was an engineer of great experience. Upon the order of April, 1899, being made, he gave this gentleman instructions to carry out this order. Personally he had never designed, made, or sold any lamps in breach of that order. To his knowledge there had been no evasion of the order of the Court.

Mr. Esson, the defendant's engineer, deposed that the order of April, 1899, had been carried out. Two hundred lamps had since been sold, but none of them were Victoria lamps or infringed the plaintiffs' patent, and they were not constructed in breach of the injunction. When the order was made he at once made it his business to reconstruct the arc lamps of the defendant, so as not to include the structural features alleged by the plaintiffs to comprise his claim, and not to infringe plaintiffs' patent. None of the features described and specifically claimed by the plaintiffs were included in these lamps. The points of difference were such as to place the lamps wholly outside the scope of the plaintiffs' specification. The mere repetition of certain of the numbers mentioned in the order could not injuriously affect the plaintiffs. The Victoria lamps referred to were originally sold by the defendants in September, 1897 and 1898. In respect of these lamps royalty had been paid to the plaintiffs under the agreement of 1899. The said lamps had been returned to the defendants and re-issued in the ordinary course of business.

Prof. Silvanus Thompson, in his affidavit, said that he had been familiar for some time with the lamps manufactured by the plaintiff company and by the defendants. He had examined the Victoria lamp, and the No. 16,338, and found two substantial and complete differences between them. In respect of the features which the lamps had in common, the defendants were using nothing that was not common to all the world, and well known prior to 1892.

Evidence was then called.

Mr. Brockie, the plaintiff, cross-examined by Mr. Fletcher Moulton, said that his affidavit of February, 1898, was in an action for infringement of letters patent. He had applied for an interim injunction. In paragraph 4 the invention claimed the combination of a spring brake supplementing the main brake on the regulating wheel. That was one of the points in which he alleged that the Victoria lamp made by the defendants infringed his patent rights. As a matter of fact, the lamp he complained of has no spring brake supplementing the main brake. The letters patent 12,982, of 1894, were granted in respect of an invention of an arc lamp in which the crown plate was fixed to the top U-shaped piece within which the brake and focussing wheels were placed. In that patent for the first time he showed this U-shaped piece attached to the top piece and holding the wheels. That he considered novel at the time. The globe gear was supported by a single tube attached at its upper end to the base plate. It also acted as a guide to the carbon rods. This last was not to be found in the lamp complained of. The U-shaped frame was practically the same in both lamps. The whole of the lamp was quite free to the public except the point he had mentioned. In the letters patent 23,825 of 1894 the claim was for controlling the great wheel or wheels by means of a loaded band in combination with levers. In the lamp he complained of the band was loaded by means of a heavy weight attached to it. Band brakes were common for years. The releasing of the brake was the main thing in the patent.

Mr. Shrimpton said he had negotiated the settlement of this action. In making the settlement he intended to clear up all the past disputes. The payment of £1,675 was in respect of the lamps previously made by the defendants. He had never made any attempt to interfere with the user by the public of lamps included in the settlement.

Mr. Dugald Clerk was called, and gave evidence as to the details in which the two lamps differed.

Mr. Moulton, on behalf of the defendant, said that his learned friend said that the defendants' lamps did not differ from the plaintiffs', or if they did it was in matters perfectly immaterial. He admitted that if the defendant was repeating that which had been complained of, he could not go back on the question of whether it was an infringement of the Victoria lamp. If his friend could say the defendants' lamp was identical with the plaintiffs' he would support his case. But the moment he left identity his case disappeared. There was no such thing as substantial identity in the abstract. You had to consider what were the material points by which you were to judge or not judge of the identity. For instance, it might be said that the defendant was not to sell lamps of a particular size or strength. Then, if you could show that he was selling lamps of that size or strength, the case would be proved. But here the action was for infringement. Under the circumstances identity was destroyed, if once you showed that any points which were taken as material were points in which the lamps differed. There were these differences between the two lamps, and he submitted that the plaintiff had not made out a case to justify the granting of a committal order.

His Lordship said that, in his opinion, there was substantial identity between the two lamps, the Victoria lamp and the lamp No. 16,338. The endeavour to distinguish them had been slight. Certain differences had been pointed out, but it was clear that these differences were mere differences in detail which did not interfere with the real identity of the lamps. He had no doubt that they were adopted in order to enable the defendant to put on the market Victoria lamps substantially like those mentioned in the order. It seemed to him that the plaintiff had proved his case. It was useless to go through the differences in detail, because to his mind the evidence was overwhelming that the differences were only differences in detail. What he had before him in No. 16,338 was substantially the Victoria lamp. He had no doubt that the defendant had been attempting to evade the order of the Court if possible. He had not succeeded. There would be an order for committal, and the defendant must pay the costs.

Mr. Moulton asked for a stay of the order, pending an appeal.

His Lordship said the order must be drawn up, but a stay would be granted if an immediate application were made to the Court of Appeal.

Mr. Moulton said he would apply at once.

[The case was ultimately settled by agreement—see our "Notes" columns.—Eds. Elec. Rev.]

Judgment in the Castner-Kellner Appeal.

The Manufacture of Caustic Soda.

The House of Lords gave judgment yesterday in the appeal of the Castner-Kellner Alkali Company, Limited, *v.* The Commercial Development Corporation. The action was brought by the applicants for an injunction to restrain the respondents from infringing letters patent granted to Carl Kellner for an alleged invention for improvements in electrolytic apparatus for decomposing metallic salts.

The Lord Chancellor, in giving judgment, said: In order to appreciate the real nature of the dispute in this case one has to

remember that no chemical discovery is in question, no new mode of producing caustic soda, so far as the electrolysis itself is concerned. The decomposing of common salt and water by electricity and making an amalgam with mercury and sodium so as to leave as a product caustic soda is common to all the patents that have been brought before us in the course of this discussion. Between the immediate parties to this appeal there is therefore nothing whatever in dispute except the mechanical machinery by which this chemical process of producing caustic soda can be put in operation. Now, Kellner, whose patent is now in question, described in his provisional specification the mechanical contrivance by which the process to which I have referred has to be put into operation, and the whole point in dispute is whether in the description he has given in his provisional specification, he has, or has not, described the invention which he claims in his complete specification, or whether the latter does not, in addition to what he has described in the former, claim something different and outside his original claim? That is the whole question. Now, there cannot be any doubt that an essential feature of his invention is what he has called a stationary mercury cathode, and the question may be further narrowed to the single point—in what sense the word stationary is to be understood? It is said that there are two senses in which the word stationary may be considered: stationary in respect of surrounding objects, or stationary in respect of the vessel which contains the mercury, and a scientific demonstration was made before your Lordships that the mercury in the vessel was itself at rest, although the vessel itself was subjected to a considerable movement. I have some doubt whether the experiment is a sufficient proof of the proposition it was intended to support. No actual use of the apparatus has ever been made, and no experiment such as was made before your Lordships, and its actual use in practice is a very different thing. But independent of this consideration the question must be determined by the fair construction of the provisional specification itself. It will not do to say that in looking at the complete specification there is a sense in which it is compatible with the provisional, but whether the provisional really is intended to protect the invention more minutely described afterwards in the complete specification Now I am unable to say that I think the provisional specification here ever contemplated the movement in any sense of the mercurial cathode. It is impossible to read the concluding part of the provisional specification without being struck by the absence of any hint of the arrangement claimed afterwards. These are the words: "If the bells, after a suitable interval of time, be shifted back into position shown in full lines, *i.e.*, to the right hand, the mercury on the left hand side of the anodes, together with the amalgam formed thereon, becomes situated in the combining chamber of the trough, and consequently within the sphere of action of the water in such chamber. It will thus be seen that by the to and fro movement of the bells the transposition of the amalgam formed in the decomposing chambers to the combining chambers, and the practically continuous formation of caustic soda in the latter, are caused to take place alternately on the one side and on the other side of the anodes, whilst the mercury cathode itself remains at rest." Now it may be true that the mercury itself is the cathode, and not the vessel in which it is contained; but this is a description of a mere mechanical appliance, and I cannot doubt that when this description was given the thing which was meant to be at rest was the mercury and the vessel containing it, and I have come to the same conclusion as the Master of the Rolls—that the Claim 3 and the figures 7 and 8, to which it refers, are an entire departure from the essential features of the invention, as originally described. I look upon the language of the complete specification as an ingenious effort to avoid what would be a glaring disconformity, and which has received the assent of Mr. Justice Bigham and Lord Justice Vaughan Williams, but, as I have said, I think one must look at the provisional specification, and then consider whether it is really describing what is now claimed, or what is in its essential features a different thing. I think it is, and for this reason I think the judgment of the Court of Appeal was right, and ought to be affirmed.

Lord Macnaghten: This case comes before your Lordships under somewhat peculiar circumstances. The appellants, who were the plaintiffs in the action, charged the defendants with infringement. The appellants' patent has never been put into practice at all. The defendants' patent has never been used commercially. The rival inventions are therefore little more than paper inventions. That being so, it is certainly not surprising to find that expert witnesses are by no means agreed as to what would happen in actual working. But it may be assumed for the purposes of this case that the defendants' patent, if it should be worked on an industrial scale, would be an infringement of the plaintiffs' patent. The defendants, however, say that, assuming their invention to be an infringement of the plaintiffs' invention, the plaintiffs' patent is bad for disconformity. And that seems to be the substantial question between the parties. It depends upon a very narrow point. What is the meaning of the expression "Stationary mercury cathode"? That is the thing upon which the provisional specification insists, and it is the gist of the invention there described. Now, notwithstanding the very ingenious argument of Mr. Moulton and Mr. Bousfield, I am not satisfied that a revolving mercury cathode is a stationary mercury cathode, provided the mercury within the vessel containing it is not shaken at all, or only slightly shaken by the rotary motion to which it is subjected. I do not see why you should give the word stationary a non-natural meaning. It seems to me that if the mercury were put in a long trough, or in a series of troughs under fixed decomposing chambers or bells, and the alternate presentation of patches of charged mercury and uncharged mercury were effected by moving the trough or troughs to and fro, a very violent disturbance and churning up of the mercury would probably be produced. Now that is the very thing which Kellner wished to avoid. That would have been Castner's method over again. That is why the provisional specification insists on stationary mercury cathodes and moving bells. If there were any doubt about the meaning of the word stationary, there are other passages in the provisional specification which seem to make the meaning clear. At the very end of the provisional specification Kellner explains that the mercury cathode itself remains at rest. In an earlier part of the provisional specification he points out that the amalgam formed in the bells has, by reason of the shifting of the bells, its location alternately on one side and the other side of the bell, without itself changing or moving its position. That being so, it appears to me that when Kellner, in his complete specification, proposes to move the mercury cathode, and to make the bells stationary, he is describing a different invention from that described in the provisional specification, and an invention not merely different from that, but in its leading feature at variance with the invention described in the provisional specification. I am therefore of opinion that the appeal must be dismissed with costs. My noble friends, Lords Morris and Shand, ask me to say that they concur.

The Jandus Arc Lamp and Electric Company, Limited, *v.* William James Davy.

In the High Court of Justice (Chancery Division) before Mr. Justice Kekewich. Messrs. Faithful & Owen, solicitors to the plaintiffs, have issued a notice, dated June 22nd, to the effect that the plaintiffs wholly discontinue this action.

PARLIAMENTARY COMMITTEES.

Electric Power Bills.

On Wednesday last week a Select Committee of the House of Lords, presided over by the Duke of Argyll, commenced the consideration of the group of electric power Bills which were recently considered by Sir James Kitson's Committee, and reported at length in the Electrical Review.

The County of Durham Bill was the first taken, and the promoters were represented by Mr. Balfour Browne, Q.C., Mr. Worsley Taylor, Q.C., and Mr. Moon. Mr. Fitzgerald, Q.C., and Mr. Lloyd represented the District Council of Felling and Hebburn, who were the only opponents against the Bill.

Mr. Balfour Browne, in opening the case for the promoters, explained to the Committee the exhaustive character of the inquiry which had been held by Sir James Kitson's Committee into the provisions of the Durham, Lancashire, and South Wales Bills, and referred to the fact that the most important clauses which were introduced for the protection of the public and the local authorities were framed by the Government draughtsmen, and were put upon the several promoters by the House of Commons Committee. He therefore asked their Lordships to pass the Bill exactly as it left the other House. It was proposed by the Act to establish a generating station on the River Tyne, and it was hoped to be able to generate electricity very cheaply. Tyneside would be a splendid customer, as there were very large works there to which electric energy would be of the greatest use. Going through the principal clauses of the Bill, including those inserted by the Committee for the protection of the public, he said that there never had been better protection provided in any Bill. Felling, in their petition, complained that they would be injuriously affected by the provisions of the Bill. He, however, on the other hand, hoped to be able to show that, so far from being injuriously affected, the district would be benefitted.

Evidence was then called in support of the Bill to the effect that it was proposed to supply electricity on a wholesale scale, by which it was possible to supply it more cheaply. The result would be that it would be put in the reach of people who would not be able to afford it if it were expensive.

The Chairman said the Committee did not wish to hear a great deal of evidence in favour of the scheme, but would like to hear what the opponents had to say.

Mr. Balfour Browne said he had witnesses from Gateshead, Jarrow, Whickham, and other places if the Committee desired to hear them.

The Committee said they would have a Gateshead witness.

Alderman Scott, of Gateshead, was then called and gave evidence to the effect that it would be a very great boon to the district if this Bill were passed.

Mr. Fitzgerald briefly addressed the Committee in opposition to the Bill. South Shields, Sunderland, and the Hartlepools had, he said, been cut out of the Bill because they raised objections, and he asked the Committee to also cut out Felling and Hebburn. Hebburn had already obtained a provisional order to supply electricity within its own area, and Felling had undertaken to apply for similar authority next session. Both Councils were willing, however, to reserve to the proposed company the right to lay the mains through their districts, in order that they might supply the town of Jarrow if they wished to do so.

The Duke of Argyll, in announcing the decision of the Committee, said they were of opinion that the Bill might proceed with the exception of the clauses which included Felling and Hebburn in the area of supply. Those clauses should be altered so that only wayleaves through those districts should be allowed.

The Lancashire Bill.

The Bill which proposes to incorporate a company for the supply of electricity to the whole of Lancashire south of the Ribble was next proceeded with. Counsel for the promoters were Mr. Worsley Taylor, Q.C., Mr. Erskine Pollock, Q.C., and Mr. Joseph Shaw, and the Bill was opposed by the following Corporations:—Liverpool Corporation, represented by Mr. G. A. K. Fitzgerald and Mr. Lewis Coward; Bootle Corporation, by Mr. G. A. K. Fitzgerald; Bolton Corporation, by Mr. Freeman, Q.C., and Mr. Lewis Coward; Manchester Corporation, by Mr. Balfour Browne, Q.C., Mr. Wedderburn, Q.C., and Mr Geo. Rhodes; Salford Corporation, by the Hon. J. D. Fitzgerald, and Mr. J. H. Lloyd; Southport Corporation, by Mr. J. Davies Williams.

Mr. Worsley Taylor, in opening the case for the Bill, said that its object was to supply electricity within an area which embraced the whole of Lancashire south of the Ribble. The principle to be adopted was the same as that in the Durham Bill, the energy being supplied from large generating stations, the sites of which were carefully chosen, having regard to the desirability of cheap manufacture by reason of their proximity to the coalfield, and in the present case not only were they practically on the coalfield, but had also the advantages of railway and water carriage. He did not think he could better describe the area to be dealt with than in the words of the petition of the Corporation of Liverpool, which stated that it contained about 1,100 square miles, and an estimated population of upwards of three millions, and included in its area Liverpool, Manchester, and 30 other large towns which they named. If one had gone all over the county, one could not have picked out a more densely populated area, or one that contained a larger number of important towns, or an area in which there was such a mass of industries. It covered one large coalfield, and two minor ones, and of course there were collieries of considerable importance, and very large engineering works in the district. Therefore there could not be a more suitable area, or one which required more a supply of electricity. They had not only taken in the lucrative, but also the other parts of the district. Of the demand, they could not have better evidence than that which was afforded by their opponents on the last occasion. There were 129 authorities in this area. In 16 of those there were works in operation on which a million and a half had been spent. There were five in the course of construction. One station, such as the promoters proposed, would practically do the work now spread over 21. There were 19 districts with provisional orders but no works, and 187 with no orders at all. So it would be seen that there was a large undeveloped area over which to supply electricity. He described the four stations proposed to be established, and said that only one would be first constructed. He presumed the next step would be to put down substations to be gradually converted into new generating stations. The total estimated cost of the four stations would be two millions of money, and they had sufficient capital to start with a margin for expansion. They expected to be able to supply at 1½d. per unit, and he thought that the price was one which would create the demand. Their price was a 1d. less than the best known price in the whole of Lancashire. They did not force this on anyone; they only asked for the permission to offer it. There was no doubt of the capital (three millions of money) being raised. The Bill came before the Committee, settled with unusual care. There was an obligation upon the promoters to supply any quantity of electricity which anyone of the local authorities might reasonably demand. Dealing with the petitions, representing the opposition to the Bill, he said there would not be the same opposition as in the other House. There, there was a lot of opposition to certain clauses, the petitions numbering 57. That day there were six petitions appeared upon, and one (Stockport) had reserved counsel. The petitioners were Manchester, Salford, Liverpool, Bootle, Bolton and Southport. Treating Manchester and Salford as one, and Liverpool and Bootle as one, there were only four petitions. Some of these said they could supply themselves, whilst others objected to wayleave. With respect to the last point, the people raising it had no right to prevent the rest of the country getting what they wanted. As to the first point, what harm would it be to bring those places in? They could decline to take this electricity if they did not wish to have it.

On Friday Mr. Worsley Taylor, Q.C., continued his address, and dealt at length with the petitions of the Manchester and Salford, Liverpool and Bootle, Southport and Stockport Corporations, who objected to being included within the proposed area of supply, and to granting wayleaves to the company through their districts. He strongly urged the Committee not to exclude the area of any of the petitioning municipalities from the Bill, and cited, in support of his claim, the statement made by Mr. Ritchie in the House of Commons during the second reading debate on those Bills, that it was distinctly contrary to the public interest that an intervening authority should be allowed to refuse a company permission to go through its district when it desired to supply electricity to a district beyond its boundaries. In the majority of the cases the learned counsel said it would be absolutely impossible for the intervening authority to afford the district beyond a supply of electricity either for lighting or power, and he therefore asked the Committee not to sanction the dog-in-the-manger policy which was involved in the attitude of the opposing Corporations. If those Corporations did not wish to have electricity from the company, they would sustain no harm by the company passing through their areas, and they should not be placed in a position to prevent their neighbours from obtaining what the company had to offer. He particularly referred to Manchester, which, he said, not only complained of the streets being broken up, but claimed the right to prevent the promoters from going through the district of neighbouring authorities not petitioning against the Bill.

Mr. Balfour Browne, Q.C., for the Manchester Corporation, said he did not, and had no right to object, to anything done to the roads outside Manchester.

Mr. Worsley Taylor said that that shortened the matter, and further referring to the petition of the Manchester Corporation, said that the promoters would not break up the streets of that city. They would simply bring the electric power to a convenient place for the use of Manchester if they cared to have it. He would point out that various other towns of considerable size assented to the Bill, and he asked what difference there was between them and Manchester. He used the same argument respecting the Salford opposition, and pointed out that the promotors simply wished to lay wires through the town to get beyond, and that they would not supply electricity to any tram company or such like use.

Mr. F. Gripper, an electrical engineer, one of the promoters of the Bill, and manager of Edmundson's Electricity Corporation, said the scheme would be of the utmost advantage to Lancashire. In the county 19 local authorities had had their provisional orders for a long time—some as long as 10 years—but they had carried out no works. As many as 87 districts had made no effort at all to get provisional orders.

In cross-examination, the Witness said that Manchester could do for itself what the Bill proposed to do when all their plans were carried out.

Mr. Lewis Coward, representing Liverpool and Bootle, during cross-examination put in figures to prove that Liverpool at present provided electricity more cheaply than could be done by the promoters, and would, therefore, never require their assistance.

Mr. Davies Williams, for Southport, asked witness to mention half a dozen local authorities out of the list of 66 before the Committee who could supply electricity as cheaply as Southport.

Witness replied that he could not, and added that the promoters would be willing to contract to supply Southport at half their present cost.

The room was then cleared, and on the readmission of the parties the Chairman stated that they did not care to hear much more evidence regarding Manchester, Southport, Stockport, Salford, Liverpool and Bootle. He suggested they should hear a Bolton witness.

Mr. Worsley Taylor, Q.C., asked whether the Committee had arrived at any conclusion with respect to the other places?

The Chairman replied that they had not made up their minds.

Mr. Caldwell, J.P., of West Houghton, one of the promoters, gave evidence supporting the scheme, and said he thought it would be of great benefit to the Lancashire collieries.

Mr. Leech, mining engineer and chairman of the Urban District Council of West Houghton, also gave evidence in favour of the Bill, and was supported by Mr. Scully, the chairman of the Electric Committee of the Urban District Council of Gorton.

The room was again cleared, and on the re-admittance of the public,

The Duke of Argyll announced that the Committee were of opinion that the Bill might proceed, but that Liverpool and Bootle, Manchester and Salford and Stockport should be excluded from the proposed area of supply. In the case of Bolton the Committee were of opinion that the mains must be taken at least 2½ miles distant from the town hall of the borough.

Mr. Balfour Browne, Q.C., asked the Committee if they would reconsider the position of the Southport Corporation. Southport was an absolutely outlying place, and the promoters could not want to go there at all. He had evidence to the effect that there was no place to supply by going through Southport, and he asked permission to call it.

The Chairman assented, and it was decided to call the Mayor of Southport, Mr. Worsley Taylor, Q.C. (for the Bill) intimating that he would not cross-examine, but leave the matter to the Committee.

The Mayor of Southport then went into the witness chair, and bore out the statement of counsel for that borough, and explained that Southport was doing for itself all that this Bill proposed to do; Southport was anxious to be excluded from the measure.

The Committee decided not to alter their decision of the previous sitting, after which clauses were adjusted. The promoters brought up clauses in accordance with the decisions of the Committee, and now Manchester, Salford, Stockport, Liverpool, Bootle, and practically the whole of Bolton will be excluded from the operation of the measure. The clauses were approved, and the Bill ordered to be reported for the third reading.

South Wales Power Bill.

The South Wales Electrical Power Distribution Company's Bill took up very little time of the Committee, there being little opposition; the only opponents were the Swansea and the Aberdare Gas Companies, who were represented by Mr. Shaw. There had been a number of petitions against the Bill, but these had been settled with. Mr. Pember, Q.C., Mr. Ram, Q.C., Mr. C. A. Russell, Q.C., Mr. Trevor Lewis, and Mr. Acworth were for the promoters.

Mr. Pember, Q.C., very briefly laid the facts of the case before the Committee, to the effect that the promoters desired to supply over an area of 1,075 square miles in South Wales, the district being very largely manufacturing. The promoters of the Bill were all largely interested in the industrial undertakings of the district, and altogether represented capital of £24,000,000 employed in that part of the country. The total capital of the company would be £750,000.

The Swansea and Aberdare Gas Companies, who were now the only opponents against the Bill, wanted to be protected against the possibility of injury to their mains and pipes by fusion or electrolytic action, to which the promoters had no objection. In fact, when the Bill was before Sir James Kitson's Committee of the House of Commons the promoters gave the opponents a clause for their protection, but the Committee considered that the gas companies were sufficiently protected by the General Electric Lighting Acts, which were incorporated in the Bill. He was perfectly willing to allow the Swansea and Aberdare Companies to be included in the clause which protected the Pontypool Gas Company, and which had been allowed to remain in the Bill.

The Chairman said the Committee would allow this to be done, and they accordingly passed the preamble of the Bill and made the alteration in the clauses.

It was promised by the chairman to avoid delay that the Bill should be reported at once to the House.

Shannon Water and Electric Power Bill.

The Shannon Water and Electric Power Bill was next taken, the promoters being represented by Mr. Bushe, Q.C., Mr. Blennerhassett, Q.C., Mr. Mahoney, Mr. Connor, and Mr. Greig. Mr. Balfour Browne, Q.C., Mr. H. Lloyd, and Mr. E. Phelps represented the Conservators of the Limerick Fishery District, who opposed. When the Bill was before the Commons Committee, the Fishery Conservators withdrew from the room on the Chairman ruling that they could only oppose certain portions of the Bill.

Mr. Bushe opened the case for the promoters, and said it was proposed to supply an area of about 30 square miles from a generating station at Cloonlara, County Clare. It was intended to utilise the waters of the Shannon by constructing a canal with a drop of 40 feet. It was proposed to incorporate a company with a capital of £300,000 and borrowing powers of £150,000. There would be supplementary steam power to be utilised if required. There was practically a unanimous feeling in favour of the scheme in the district, with the exception of the Fishery Conservators, who thought the fisheries of the whole of the River Shannon would be prejudicially affected. There were a number of local industries which it was confidently anticipated would be greatly benefitted by the scheme.

Mr. S. G. Frazer, the engineer to the scheme, was called, and explained in further detail the objects of the Bill. He pointed out the high cost of generating electricity in the district, in consequence of the cost of coal. He considered the suggestion that the fishing would be prejudicially affected was absurd, for all the water used would be returned to the river, and it was proposed to construct a weir to regulate the flow of water.

In further cross-examination, Witness admitted that the promoters would have to come to Parliament again next session for authority to carry out the weir scheme.

Thereupon the Committee considered the matter, and the Chairman announced that they regretted that at present the scheme was incomplete, inasmuch as it was stated that the promoters would have to come to Parliament again for the completion of the project. They would be willing, however, to hear counsel on the point.

The further hearing of the case was then postponed.

On Monday the Bill was again before the Committee, when they found that the preamble was not proved, and that the Bill would not therefore proceed.

Morley Corporation Bill.

The Bill of the Morley Corporation came before Mr. J. W. Lowther's Committee of the House of Commons as an unopposed measure last Friday. The objects of the Bill are to extend the borough boundaries, and to make further provision in regard to the water and electricity undertakings. When the Bill was before the House of Lords Committee, the Committee refused to allow the Corporation to supply electricity in bulk in outside areas without the consent of the local authorities, and a clause to this effect was inserted.

Tramways at Bootle and St. Helens.

The provisional order Bill conferring powers granted by the Board of Trade to the Bootle Corporation, the Radcliffe Urban District Council, and the St. Helens Corporation for the construction of tramways in those districts, came before Mr. Lowther's Committee of the House of Commons last Friday, and passed as an unopposed measure.

Southport and Lytham Tramways.

On Friday last week the Southport and Lytham Tramway Bill came before Lord Morley's Committee of the House of Lords as an unopposed measure. Under the Bill a tramroad is to be constructed along the south shore of the Ribble from a point where the authorised lines now end, and to a point opposite the firm sands of the estuary. Hence, by means of a pier and conveyer bridge the tramway will be carried to the north bank, returning westward to Lytham, and there joining the Blackpool, St. Anne's and Lytham Tramroad, and thus completing tramway communication between Blackpool and Southport. It was originally proposed that the height of the bridge should be 147 feet, and that the tramcar should be carried across the river by means of a cradle, from 50 feet to 60 feet long, capable of carrying an electric car and trailer. The project was opposed by the Preston Corporation, who, however, withdrew their opposition on the promoters undertaking to make the girders of the bridge 177 feet high.

Bournemouth Tramways.

The Bill of the Bournemouth Corporation was passed by Lord Morley's House of Lords Committee on Friday as an unopposed measure. The Bill provides for tramways in the borough to be worked electrically. There will be an interchange of running powers with the company running tramways from Christchurch on one side of the borough and Poole on the other.

Weston-super-Mare Tramways.

This Bill came before Lord Brassey's House of Lords Committee last week, the only contentious question being as to damage which might be done to the cables of the Commercial Cable Company by reason of the escaping current from the tramways interfering with the delicate instruments at the station. The Committee passed the Bill, but did not grant any protective clauses to the cable company.

Manchester Tramways.

The Bill of the Manchester Corporation to authorise them to construct additional tramways within the city and to make agreements with outside authorities in respect to the working of tramways, was before Mr. Seale Hayne's House of Commons Committee on Tuesday and Wednesday last week. The Bill has already passed the House of Lords. The opponents were the British Electric Traction Company, who had obtained an order for the construction of a light railway in Middleton, and therefore contended that they were the proper authorities to construct tramways in that district.

Mr. Entwistle, the town clerk of Middleton, gave evidence that his local authority approved of the agreement with Manchester, and preferred that the Corporation should work the tramways.

After hearing evidence the Committee passed the preamble of the Bill.

Southport Tramways.

On Thursday last week the Southport Corporation Bill came before the Unopposed Bills Committee of the House of Lords, and was reported for third reading. The Bill gives the Corporation power to extend the existing tramways and convert them for electric traction, and a working agreement has been entered into between the Corporation and the company owning the tramways in Southport and Birkdale.

Plymouth, Stonehouse and Devonport Tramways.

The Plymouth, Stonehouse and Devonport Tramways Bill came before the House of Lords Committee on Unopposed Bills on Friday, and was ordered to proceed. The Bill confers further powers on the Plymouth, Stonehouse and Devonport Tramways Company to construct double lines of tramways and to work the existing system and extensions by electric traction.

Municipal Trading.

The Committee at its sitting last Friday heard evidence from Mr. E. L. Gaine, general manager of the National Telephone Company, who said he wished to draw attention to the evidence of the Lord Provost of Glasgow, in which he alleged that the justification for the Corporation of Glasgow undertaking to compete with a private enterprise in the telephone service was on account of the inefficiency of the company's service, and practically the refusal of the company to put it on a better basis. He (the witness) quite recognised that the quarrel between the Corporation of Glasgow and the National Telephone Company was not the subject of inquiry before the Committee, but with reference to the Lord Provost's statement, he would like to read the report of a Treasury Commissioner given after a very long inquiry held in Glasgow in 1897. The Corporation had been extremely importunate to have a license to conduct telephone business, and the result of their importunity was that in 1897 the Treasury appointed the Sheriff of Perthshire, an entirely independent person, to take evidence as to the facts. The evidence was given upon oath, and occupied 12 consecutive days' sittings. In his report the Commissioner stated that in his opinion the continued inefficiency of the then telephone exchange service in Glasgow was in a great measure due to the refusal by the Corporation of facilities to the company for constructing an underground metallic system. The reason why the Glasgow Corporation stood in the way of the company was that they hoped to establish a telephone system of their own by means of which they believed they would have been able to extinguish the company altogether. The witness then gave particulars as to the negotiations which his company had had with the Corporation of Glasgow in 1896, with a view of putting their system on the best possible basis without necessitating interference with the streets, and said that the negotiations dragged on month after month, until they finally resulted in a definite refusal to allow anything to be done at all. On the general question he did not think that the telephone was a proper subject for municipal supply.

He did not consider that competition in telephones was the right thing at all. His view was that the service was part of the telegraph service of the State, and ought to be in the hands of the State, and if it was not, then it ought to be a controlled monopoly, something like a great railway company. The presence of so many local areas made competition very undesirable, and he might point out that, notwithstanding the Act passed last year which allowed competition, he did not believe that there were more than two or three municipalities in this country, with the exception of Glasgow, who had thought it wise even to consider the question of embarking upon such a subject.

Questioned as to the competition in other countries, the Witness said that there was no competition in France or Germany, where the telephone was in the hands of the State. In point of fact, there was no competition anywhere in Europe, except in Sweden, and there competition only existed in Stockholm, and that was between a great company which had the bulk of the work, and the State. The two lines there were not joined, but by arrangement subscribers could be connected. In America the telephone was dominated by one great finance corporation, and there was a certain amount of competition.

The Committee adjourned.

CORRESPONDENCE.

Institution of Electrical Engineers and Sunday Observance.

I wish to heartily endorse the public protest of your correspondent regarding the proposed Sunday trip on August 12th. When I received the notice it promptly found its way into the waste paper basket.

If other arrangements can be made for the entertainment of the American Institute of Electrical Engineers, I shall be pleased to do what I can to assist in giving a true *British* welcome to the guests. Did not our worthy secretary mean French when he wrote British?

W. P. Adams.

London, *July 27th*, 1900.

[We have received another letter on this subject, which, however, borders on irreverence, and we do not care to publish it.—Eds. Elec. Rev.]

Motor Starters.

My attention has been called to a letter in your issue of July 20th, signed by Mr. C. B. Callow, in which he says:—"It seems to be a general complaint that there is no good (motor) starter in the market. My experience is, that all the starters available are rated too high for their work, and are very expensive in first cost." Now I have, on behalf of my firm, been advertising in the columns of your journal for some three or four years past a motor starter, the "Ironclad," of which it can be safely said that not once in 100 times has it been burned out when subjected to the load for which it has been intended to be used, and I am free to confess that that is my own idea of a good piece of apparatus of any sort; that it does the work for which it is made. But the trouble is that the user, as a general thing, either does not know, or, if he does know, will not tell, what he actually wants a rheostat to do. My idea has always been that it is cheaper to burn out a rheostat than a motor armature, and therefore I seldom calculate on more than a 50 per cent. overload; and just here comes in the question of what is a 50 per cent. overload? In spite of the general high state of electrical knowledge in this country, it appears to me that when a man buys a rheostat made for 100 amperes, and puts 150 amperes through it, he is under the impression that he has not exceeded that limit, whereas, needless to say, he has actually subjected the instrument to a 125 per cent. overload, as it is watts which we are dealing with and not current, and watts have an unfortunate habit of rising as the square of the current. I had a small speed regulator returned to me not a week after it had been sold, with the information that it had been burned out "immediately it had been put in use." I sent a new one, only to hear of the same sad fate having overtaken it. I did it again, not unto seven or unto seventy times seven, but three times, and then thought it was time to get a personal explanation of the affair, for *post mortem* examination proved that a very excessive current had been used. I found that motor running a circular saw, with a current of about 75 per cent of what the speed regulator was made for, and was told that that was all it was ever asked to do. A little cross-examination of the man running the saw produced the following amazing reply, "No, it never has more to do than now, *but every time the saw jambs and stops the resistance burns out.*" Well, as there was no cut-out on the mains no one living can tell what exact overload that poor thing stood before it gave in. There are cut-outs there now and complaints have ceased.

Again, a starter is not a speed controller, and if it is used as one will certainly burn out. Ironclad starters are usually issued for 30 seconds service, and if they are required to be kept in circuit for a longer time speed controllers should be used. Lack of proper information often leads to too small a starter being selected, as in the case of printing machinery and other things, the starting torque of which is sometimes 350 per cent. to 400 per cent. of the full torque when running. In such a case it is easy to see that the starter may burn out, whilst the motor, which is intended to carry its full load current for any number of hours will not be injured by even that amount of overload for a short time; if a speed-regulator were used it would not be troubled over a 400 per cent. starting overload either. As to the first cost being high, I do not think 10s. per H.P. on a 5-H.P. motor, or 6s. on a 100-H.P. is an excessive price for a good starter, or that the amount of current wasted in starting cuts any figure at all in the cost of running a motor. Take a 100-H.P. 500-volt motor, even if the machine did not start until all the resistance was cut out, it could only waste about a quarter of a unit each time it was started on full load. The use of a "lightly rated starter" would, I fear, be a failure unless, which it would seldom be, it was in charge of a qualified electrician; as it would be ten to one the motor man would throw in the fast pulley before he had the starter cut out of circuit, and besides all that at the absolute moment of first putting the current on to the standing motor there would, loaded or not loaded, be a rush of current far in excess of what the "lightly rated starter" would stand.

It would take a considerable amount of writing to tell all that should be known about motor starters and speed controllers, but I have said enough, I trust, to show that it is not so much the want of good instruments as knowledge how to use them that is wanted.

Douglas C. Bate.

July 25th, 1900.

Long-Distance Telephony.

In commenting on a paper on "Dr. Pupin's Improvements in Long-Distance Telephony," repeated in your issue of June 22nd, pp. 1039—1041, you speak of two statements as incorrect—(*a*) "The use of a submarine cable in telephony over a greater distance than 27 miles in length (Dover to Calais) is not supposed to be practicable." If you could describe experiments where this has been accomplished, or mention instances where long-distance telephony over greater lengths of cable has been carried on in practice, I am sure you would be affording information not only to the undersigned, but to a number of electricians with whom he has conversed. (*b*) You speak of the K R of 125 miles of the artificial cable described, as 10,406, through which speaking you say, is perfectly practicable. In your calculation of K R you must not forget to multiply the mutual capacity by 2, as ·074 is the mutual capacity. This would give double the value, and possibly change your opinion on the matter.

The Author of the Paper.

New York, *July 20th*, 1900.

The Maintenance of Electric Motors.

May I claim a few inches of your valuable space to say a few more words on the above subject? When I made my little stand for cheap motors I knew I was preaching "flat blasphemy," but I still hold my opinions, and essentially Mr. Harris (July 13th) and Mr. Callow (July 20th) agree with me. By a "cheap" motor, I did not mean a "bad" motor, by any means, but I meant such a motor as a non-technical man would be likely to buy after studying price-lists.

Mr. Harris's experience of motors has been far longer than

mine, and from his account, which is no doubt correct, he makes a wonderfully good motor. It appears to run well with little or no attention; that is what I said good motors would do. I do not know Mr. Harris's prices, but I think it probable he could buy a motor of sorts at half his rates. Will it run the same? I think not, without skilled attention.

I *do* think the case I mentioned is a great performance. I know that some motors run well with the brushes fixed, but the majority require the brushes moved for every change of load.

Again, it requires a good motor—like those of Mr. Harris—to stand the current being switched on suddenly, which is the usual way with unskilled men, at least as usual as dirt and lack of oil.

I think Mr. Harris is too severe about cheap insulation. There is seldom above 10 volts between adjacent conductors on a motor—more frequently one or less—yet we put on insulation that would stand 100. Tape or paper is, in my opinion, quite good enough. That is heresy again.

Mr. Harris says I am making a stand for either motors with a great name or skilled men. I am not. I am for *good* motors or good treatment. Mr. Callow goes further. He speaks for good motors *and* good treatment. I cannot add anything to what has been said on the subject of starters.

John Carew Knight, A.I.E.E.

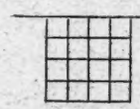
Walthamstow, *July 30th*, 1900.

Dynamo Design.

As a regular reader of your paper, I desire to ask for information on a matter of dynamo design. The question runs thus:—

What will be the voltage generated and delivered at the terminals of a four-pole dynamo of the following particulars:—

Drum armature.—Simplex winding. Parallel grouping with lap winding, there being discs (of 7 inches diameter) with 32 slots, and 512 pole facing conductors, 64 coils, and 64 commutator bars. Winding disposed thus in the 32 slots:—



Diameter over discs, 7 inches; hole, 1⅜ inches. Length of armature, 4¾ inches. Magnet core is 4¾ inches wide (parallel to shaft), and 3½ inches thick = 16·5 square inches, and worked at 80,000 lines per square inch; leakage coefficient taken as 1·25; speed, 1,300 revolutions per minute.

Brush spindles are cross-connected, viz., the two positives and two negatives, and thence to the terminals of machine.

An answer to this query will oblige.

Constant Reader.

Dudley, *July 24th*, 1900.

The City of London Company's Charges.

We beg to call your attention to the way in which the City of London Electric Lighting Company is now trying to force upon its customers the very illusory "sliding scale" which, in view of the threatened competition of the Charing Cross and Strand Company, they offered us alternatively with a uniform rate of 4½d. per B.T.U. a year or so ago. This "sliding scale" is described fully in the City company's circular of May and advertisement of March last prescribing a charge of 8d. per B.T.U. for the first 12 units per annum consumed per 8-C.P. lamp installed, or equivalent (*i.e.*, 24 units per 16-C.P. lamp). Now I venture to assert that if you take a hundred of the *average sized* consumers you will not find two who could possibly profit by this scale, which was perfectly fair when offered along with the alternative 4½d. rate. One would have to use 48 units per annum per 16-C.P. lamp to bring the cost down to 5d. all round, that is, with an installation of 50 lights the consumption would have to reach 2,400 units (£50 worth of current) before *beginning* to profit by the sliding scale. This is altogether ridiculous, as you will find by examining, as I have done, several users' accounts.

My main object, however, in writing to you is to bring to your notice the fact that the company is arranging for this change to take place at this time of the year, when consumers are not likely to notice the change in rate on a 5s. or 10s. bill for the summer quarter, whereas they will notice it quickly enough when they find their winter bills doubled, and it will then be too late to object, having previously paid two bills at what I cannot help saying is an extortionate rate. I find that all my customers have received bills for the past quarter at 8d. per unit, and am therefore writing them as per enclosed copy, and if you will give further publicity to the matter you will perform a service to the consumers.

Contractor.

Bicycles and Icicles.

Please let me thank Mr. Steavenson for his useful and instructive letter which I note in your issue of to-day's date; as I am supplied from the Hove electricity works with electricity for lighting purposes, I daresay it will not be difficult, to judge from the statements of the many correspondents who have replied to my letter in a previous issue of your paper, to instal what I require in my house. The only difficulty at present seems to me that none of my many correspondents can guarantee the appliances they wish to sell me; and, on the other hand, one or two people tell me that electricity is not a very successful motive power when applied to the cleaning of bicycles or to culinary operations. However, should I see such a thing as the motor I require any time after this date, and at some local electrician's premises, I shall be happy to buy it. All my correspondents live far too far off for it to be worth my while to think of treating with them, and besides, their reluctance to guaranteeing their wares makes it impossible for me even so much as to think of ordering them.

Would those of your readers who understand the way to instal electrical plant in country houses (where such electricity can be turned to account, not only as an illuminant, but also for culinary operations and dairy work) kindly communicate with the Cunliffe Dairy Company at Worplesdon, mentioning this letter?

Henry James Saint Benno Cunliffe, M.A., Oxon.

New Club, Brighton, *July 27th*, 1900.

Electrical Engineering in the Navy.

I hardly like to let the letter in your issue of July 13th on this subject, "By One Who Has Served," pass without some reply, as possibly a few of your readers (I hope very few) may gain a wrong impression of the facts of the case.

I am glad that from your correspondent's point of view, there is room for sorely needed improvements in the Service, but after his statement to this effect he by no means substantiates it.

Most engineers ashore cannot be fully acquainted with the routine and conditions existing in the Navy, and my reason for writing on the subject was the knowledge that the statements in my letter of June 22nd were correct, and I hoped by putting the true state of affairs, in a small degree, before the engineering public that eventually some improvements might be made.

Surely it is bad policy (although comforting for the British public) to state that electrical engineering in the Navy is now in a satisfactory condition, and it is certainly not the best to lead to any improvement.

Much worse is it, and obviously a ridiculous exaggeration to say that two-thirds of a ship's company are competent electricians. If this were the case, I am afraid it would prove an *embarras de richesse*.

It is another absurd exaggeration to credit me with the belief that the efficiency of the whole Navy is below zero, because I maintain that one branch is by no means as well looked after as it might be.

Surely "One Who Has Served" ought to be able to discriminate between an engine driver, in the sense referred to by him, and the engineer in charge of the whole complex machinery of a modern battleship or cruiser, but in passing,

I should like to point out that this is the very feeling which the executive officers so often ignorantly show towards naval engineers, producing bad blood, and adding considerably to the grievances of the latter with regard to their positions as officers on board Her Majesty's ships.

I did not wish to condemn the joint described in my last letter, as an emergency joint, when doubtless it might prove of great value, but to make additional permanent joints of this nature, as is the practice, I can only repeat that it shows ignorance somewhere.

Most of the arguments in your correspondent's letter seem to me to point to the lack of *engineers*, which ought, by this time, to be well known.

In my former letter, when I proposed the employment of electricians on board our ships, I meant *competent* electricians, who would necessarily be additional officers until the system of the electrical training of officers had undergone complete reorganisation.

"One Who Has Served" is not very choice in the selection of his similies, but this I pass over, having no wish to quibble.

R. T. I. C.

BUSINESS NOTES.

Bankruptcy.—The examination took place last week in *re* Leonard Francis, electrical engineer, Southwold. Liabilities £275 13s. 7d.; deficiency £108 4s. 7d. The debtor said that he established a telephone exchange in Southwold last December, with 30 subscribers paying two or three guineas each, but the concern was not remunerative. His liabilities were almost entirely incurred for materials for the telephone exchange. Having raised a loan, he was unable to pay the first instalment, and in June all his goods, including the exchange, were seized and sold. The examination was closed.

A receiving order has been issued in the matter of Walter Vernon Scott, lately of Hammersmith, electrical engineer, in the High Court of Justice in Bankruptcy.

Liquidations, &c.—Notice is given of release, on July 19th, of the liquidator (Mr. H. de V. Brougham) in the case of the London Provincial Electrical Company, Limited.

A first and final dividend of 15s. 5½d. is payable in the case of the Chitty Dynamo and Motor Company, Limited.

The Clerk of the Rolls last week heard the petition of the London City and Midland Bank, Limited, against the Isle of Man Tramways and Electric Power Company, Limited, in liquidation, and W. H. Walker, the liquidator, brought to have a Receiver and Manager appointed of the business and property of the company, on behalf of the petitioners, who hold debentures to the amount of £65,000 of the separate undertaking, and charged collaterally as to £30,000 upon the Douglas and Laxey section. His Honour appointed Mr. W. H. Walker to be also Receiver of the company. Mr. Walker was empowered to pay the interest on the debentures and other encumbrances.

Breach of Contract.—At Manchester County Court, 23rd ult., Mercier's Patents, Limited, *v.* St. Helens Cable Company, Limited. The plaintiffs claimed damages for breach of contract and non-delivery of certain cables agreed to be supplied by the defendants. Mr. Spencer Hogg appeared for the plaintiffs and the defendants were represented by Mr. Rhodes. In November, 1899, the defendants agreed to supply the plaintiffs with two lengths of vulcanised rubber cable on terms agreed upon. A portion of the cable was delivered in December, but the defendants then declined, as the plaintiffs alleged, to deliver the remainder upon the original terms, but only on the conditions that payment was made for the first portion of the cable, and that the second portion was paid for in advance. In consequence, the plaintiffs alleged that they were unable to execute a contract for the lighting of the Winstanley Colliery, Wigan, with the electric light. The amount of damages claimed was £50. Evidence was given by Mr. J. M. Mercier, the manager of the plaintiff company, and other witnesses. Mr. Rhodes submitted that though there had been a breach of contract, the damages sustained were very slight. The Judge, who said he did not understand why the case should have been fought by the defendants, gave judgment for the plaintiffs for £21 and costs.

Books Received.—"Modern Electric Railway Motors," by G. T. Hanchett, S.B. New York: Street Railway Publishing Company.

Catalogues, Lists, &c.—We have received a circular from the Berrenberg Electric Lamp Syndicate, Limited, calling attention to their new incandescent lamp, for which long life, permanency of candle-power and economy are claimed; these qualities are ascribed in great part to the use of a high vacuum obtained by a mechanical air pump.

Messrs. Markt Bros. & Co. send us fly-sheets of particulars and prices of telephones, which can be coupled to ordinary bell circuits, trembling bells, pushes, indicators, and tumbler switches, all of which are offered at clearance prices.

A leaflet comes to hand from the Fuller-Wenström Electrical Manufacturing Company giving prices of the "Regina" enclosed motors, from 1 to 10 H.P.

We have received from the General Electric Company lists of their multipolar enclosed and semi-enclosed motors, and slow-movement motor starters with automatic release; also of reversible automatic lift controllers and motor-driven starters for machine tools, &c. The Peel-Hawkins enclosed lift motor is illustrated, as well as the complete equipment for an electric lift.

Changes of Address.—Mr. J. Ferguson Bell has left Stafford to take up the position of chief engineer and manager to the Derby Gas, Light, and Coke Company; his new address is Friar Gate, Derby. Mr. H. Pooley, his successor, now occupies the position of engineer and manager of the gas and electricity departments of the Stafford Corporation, and all business communications, in future, should be addressed to him instead of to Mr. Bell.

Messrs. Ward & Goldstone call our attention to the fact that their new address is Dutton Street, Strangeways, not Doulton Street, as we had it last week.

The Edison & Swan Company, owing to the expansion of their business, have removed their supply department to 27, College Hill (almost immediately opposite their head offices and showroom in Queen Street), where there are departments for the supply of accessories, electroliers, wires and cables, &c., &c., of which there are large and varied stocks.

Decease.—Creditors of William Dan Berry, deceased, late electrical engineer, Huddersfield, are requested to send in their claims to E. F. Brook, 19, John William Street, Huddersfield, before the 30th inst.

Holidays.—Messrs. Belliss & Morcom, Limited, inform us that their works and offices will be closed from Monday, August 6th, to Monday, August 13th, both days inclusive, during which time no goods can be received.

Liverpool Overhead Railway Company.—The directors recommend the declaration of dividends at the following rates (less income-tax), payable on and after August 16th, next:—5 per cent. per annum on preference shares, £3,000; 3 per cent. per annum on ordinary shares, £6,750; leaving a balance of £4,452 12s. to be carried forward to next half-year.

A Novel Action.—A case, which is the first of its kind in Scotland, was heard by Sheriff Reid at Edinburgh Small-Debt Court last week, when the Postmaster-General craved decree for £9 8s. 1d. against Adam Loch, contractor, Shandwick Place, Edinburgh, in respect of damage done to the telegraph line below a street in Leith, where defender was carrying on building operations. Pursuer alleged that the telegraph line was melted by the heat from a tar boiler which defender was using. It was contended for the Postmaster-General that, under the Telegraph Act, Mr. Loch was liable, and authorities from the English Courts were quoted in support of the contention. On the other hand, defender pleaded that as he did not know that the telegraph line was there, he should not be held liable. He had only carried out his operations in accordance with the recognised custom of his trade. Sheriff Reid held that defender was liable, and gave decree for the amount sued.

Outings.—On Saturday, 21st ult., a party of 70 of the Bolton Corporation gas and electric fitters, accompanied by Alderman Miles, J.P. (chairman); Councillor Horrocks, (vice-chairman); and Councillor Tootill (member of the committee); Mr. Walsh (office superintendent); Mr. Arthur Ellis, M.I.E.E. (electrical engineer), and Mr. R. Baker (gas and electric fittings superintendent), held their annual picnic at Castleton, where the "Speedwell" and "Blue John" mines were explored with interest. After lunch the party drove to Hathersage and "Surprise View." Later, Mr. Councillor Tootill on behalf of the fitters, presented to Mr. Alderman Miles, a very handsome epergne in elaborate wrought-iron and copper work, as a token of respect, and a memento of the occasion. Mr. Alderman Miles feelingly thanked them for the handsome and unexpected present. The arrangements were made by Mr. R. Baker and Mr. H. Makin, and left nothing to be desired.

The employés of the British Electric Works Company, Limited, held their second annual picnic on Saturday last. Tannworth in Warwickshire was the spot selected, and the party of 630 had a very enjoyable day.

Partnerships.—We are informed that, after a friendly arrangement with Mr. W. Schmahl, the former partners of the firm of Coxon, Schmahl & Burrell, viz., Mr. J. Coxon and Mr. J. H. Burrell, have renounced their claims as partners of the firm of Coxon, Schmahl & Burrell. Mr. S. J. Atkinson has entered into active partnership with Mr. W. Schmahl; they will take over the above business, and will in future trade under the style of Atkinson, Schmahl & Co. The working capital has been greatly increased, and the firm will shortly remove to larger premises to keep up with the requirements of their business.

Messrs. F. E. and A. S. Elmore have entered into partnership as consulting electro-metallurgists, and have opened offices at 4, Bishopsgate Street Within, E.C.

Sale.—The business of Messrs. Middleton & Co., Limited, Aberdeen, is for sale. See "Official Notices" to-day.

Watertight Switches.—A want which has up to now been unfulfilled, is that of a *really* watertight switch. The inconsistency of the common practice of installing high-class conduits,

waterproof throughout, and leaving them open at the outlets, needs no emphasis. We have just seen, however, a very neat device which is being introduced by Messrs. Newsome, Pinching & Walton, in which an ordinary high quality tumbler switch is enclosed in a metal box, and operated by an external handle, the joint being made by grinding two faces to a perfect fit. So far as we can see, this device is admirably adapted for its purpose.

Boiler and Steam-pipe Covering.—Messrs. Jones and Horsfield, of Raglan Street, Hyde, near Manchester, inform us that in these days of high pressures and superheated steam with dear coal, it is essential that the covering chosen for boilers and pipes should be the very best non-conductor that can be found, and they believe the Jones patent insulator of silicate cotton in sheet-iron casing is the most effective and durable covering for high pressures. "We often find," say they, "that the covering of a new boiler is included in the contract price for the boiler; this is a great mistake, as the best class of covering does not get put on, and there is, consequently, great loss of heat all the time the boiler is under steam."

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—At a meeting of the Gas and Electric Lighting Committee last week, Councillor Kemp, convener, presiding, authority was given to Mr. Bell, electrical engineer, to take in tenders for additional plant, consisting of two 200-KW. sets and one 420-KW. set. The new plant has to be ready to meet the demands for electric lighting in the autumn and winter of 1901.

Asylum.—At the quarterly meeting of the Durham County Council last week it was reported that the installation of electric light in the Durham County Asylum at Sedgefield cost £1,707 18s. 4d.

Austria.—The Austrian Schuckert Company, of Vienna, is preparing the plans for a projected central electric power station at Krottendorff, Styria. Water power will be utilised.

Bristol.—The Electrical Committee of the Bristol Corporation have presented to the Council a report on their work for the year ending March 25th last, which gives a good deal more information than similar publications in previous years. The number of subscribers at the year's end was 1,215, an increase of 248, and the number of 8-C.P. lamps stood at 85,956, against 68,536. During the year a number of motors have been connected, and the committee anticipate a much larger demand when their advantages are better known. The number of units sold was 1,812,511, an increase of 449,725. The accounts the committee regard as "satisfactory," considering that the effects of the reduction in the charges for private lighting made on October 1st, 1898, and for public lighting on January 1st, 1899, have been felt throughout the year, whilst only a part of the previous financial year was affected. The following are a few of the items in the account:—

Gross receipts			£31,717 14 2
Gross expenditure			17,962 1 0
Gross profit			£13,755 13 2
Interest on loans and banker's overdraft	£6,019 15 8		
Repayment of money borrowed	7,590 0 0		
		13,609 15 8	
Balance			£145 17 6

The financial position on March 25th was as follows:—

Total capital expenditure			£202,598 7 2
Mortgage debt	£228,730 0 0		
Less paid off or set aside	30,110 0 0		
		198,620 0 0	
Balance to credit of reserve fund		5,000 0 0	
Balance to credit of depreciation account		2,024 17 7	

Appended to the report is one by Mr. Faraday Proctor, the city electrical engineer, who mentions that there are 51 sub-stations and about 128 miles of cables laid. The sub-stations are constructed underneath the pavements, and consist of brick-lined chambers measuring 10 feet long by 6 feet 6 inches wide and 6 feet 6 inches deep. The engineer has analysed the accounts, from which we extract the following:—Works cost, 1·50d.; total cost, 2·18d. per unit; average price obtained for private lighting, 4·18d.; for public lighting, 1·725d. The coal bill per unit has been reduced, although the actual cost of coal per ton has been higher, thus showing additional economy in working. The load factor in Bristol is only 12·35 per cent. The average hours per annum during which each lamp is alight are only 733, or about 2·01 per day.

Chelmsford.—The Lighting Committee has recommended the Town Council to accept the tender of the electric lighting company for lighting the public lamps for five years from March 25th, 1901, at the following prices:—Arc lamps, £25 5s. each per annum, and incandescent lamps, £3 3s. each.

Crystal Palace.—The serious explosion at the Sydenham electric lighting works might have greatly affected the arrangements for the lighting of the Crystal Palace had it not been for the prompt steps taken by the Palace authorities to cope with the emergency. The supply for the theatre, the club, the dining rooms and elsewhere was received from the Sydenham works, but no sooner did the accident occur than measures were taken to enable the Palace programme to be carried through without the slightest hitch. The evening performance was given in the concert room while the Palace engineers were completing their plans to employ the plant kept in reserve within the building; nearly three-quarters of a mile of cable were laid as temporary mains, with the result that the disaster had little or no effect on the lighting of the Palace.

Dublin.—The reports of the Dublin Electric Lighting Committee and Mr. Robert Hammond, M.Inst.C.E., on the tenders for the boilers and polyphase generators for the new municipal electricity works at Dublin have been submitted to the Council, and comprise close upon 100 pages of printed matter, the greater part of which is made up of abstracts and analyses of 42 tenders for the generators and eight tenders for the boiler house plant, that were submitted in response to the Corporation's invitation. Adopting Mr. Hammond's advice, the Committee have recommended the Council to accept the following:—

Polyphase Generators with Compound Engines.

Name.	Engines.	Generators.	Amount.
General Electric Company, Limited, London.	D. Stewart & Co., Glasgow.	Oerlikon, Switzerland.	£33,061

Boiler House Plant.

Name.	Plant.	Amount.
Holdsworth & Sons.	Lancashire boilers.	£6,658
Holdsworth & Sons.	Economisers.	£1,060
Babcock & Wilcox, Limited.	Water-tube boilers.	£5,278

Exeter.—The City Council has adopted a scheme drawn up by the city electrical engineer, Mr. Munro, for a new electricity works of 3,000 H.P. capacity, of which plant for 1,500 H.P. will be installed. The estimated cost is £41,550. Mr. T. P. Wilmshurst, borough electrical engineer, Derby, has reported favourably on the scheme. There are now 19,800 lamps connected to the mains. The site of the new works is convenient of access both by water and rail. Pending the transfer and extension of their electric lighting plant, the Exeter City Council, a few days ago, decided to order three transformers of 30 KW. capacity in readiness for the winter, at an estimated cost of £210.

Faversham.—In order to prevent a company from obtaining a monopoly, the Faversham Town Council has decided to make application for powers to supply electricity.

Freswick.—Dunbeath Castle, the residence of Lieut. Alexander Sinclair, R.N., of Freswick, was recently fitted up with electric lighting by Messrs. Macaulay, Clark & Maclaren, Glasgow. This fine old castle is situated on the sea cliffs, 21 miles south of Wick, and has many historical associations.

Glossop.—The Town Council has completed the transfer of its lighting order to Messrs. Edmundson's Electricity Corporation the latter paying all costs incurred.

Gravesend.—The Town Council have received an exhaustive report from the expert (Mr. W. H. Trentham) on the subjects of electric lighting, the supply of energy to the tramway, and also upon the destruction of refuse. The estimated cost of the generating plant was £30,580, and that of the dust destructor £3,500. The Town Council referred the report to the whole Council in Committee.

Guernsey.—The new works of Edmundson's Electricity Corporation, situate at "Les Amballes," Guernsey, were formally inaugurated on July 25th, in the presence of a large and distinguished company.

Hanley.—The Lighting Committee has resolved to raise the charges for street lighting by arc and glow lamps.

Italy.—A 30-years' concession has been granted to the Società per le Strade Ferrate del Mediterraneo to utilise the water-power of the River Tierno at Vizzola-Ticino (Milan province) in the generation of electrical energy.

King's Lynn.—The accounts of the Corporation for the year ending March 31st, 1900, show that in the electricity department a gross profit of £1,372 has been realised as the result of seven months' working, against which must be set the sum of £1,366 repayment of loan and interest. Since the plant was started in August last, 126,496 units have been sold, producing an income of £2,537; rental of meters has produced £32, and sale and repair of lamps £572; of the income from the sale of current £1,036 has been obtained from private consumers at 5½d. per unit, and £1,501 from public lighting. The demand for current in King's Lynn is already far in excess of the capacity of the plant, but the Committee hopes shortly to be able to satisfy all demands, and application has been made to the Local Government Board for sanction to borrow an additional sum of £10,000 for extensions at the works.

Lancaster.—Owing to the advance in the price of coal the Electricity Committee of the Lancaster Corporation has decided to advance the prices for electrical energy as follows:—For motor purposes, from 3d. to 3½d. per unit; for lighting purposes, from 4½d. to 5d. per unit. Mr. Conn Heald, chairman of the Committee, hoped the day would come when they would use the forces in their tidal river for producing electricity, instead of having to rely almost solely on coal. The price of gas has also been raised from 2s. 6d. to 2s. 9d. per 1,000 feet on account of the increase in the price of coal.

London.—Marylebone.—The Metropolitan Electric Supply Company is about to sell its Marylebone or West London undertaking to the Marylebone Vestry. It will be recollected that the second company applying to Parliament for the confirmation of a competing order was defeated three weeks ago on the statement that a provisional agreement had been entered into with the Metro-

politan Electric Supply. The purchase price, it appears, is to be the amount of capital expended by the company up to the date of the transfer, October 1st, 1901, approximately half a million sterling. This is to be paid for in 5½ per cent. Vestry or Borough Council Bonds, so that no money will pass. It would appear that the Vestry has the best of the bargain. In the case of the Corporations of Birmingham and Sheffield, where similar transfers have taken place, they have been upon a 6 per cent. basis on the capital outlay. According to the profit and loss account of the Metropolitan Company's Marylebone order for 1899, the net profit was sufficient to pay 7 per cent. on the capital outlay. Messrs. T. H. Brooke-Hitching, Fletcher Little, and G. Panton negotiated this very important transfer for the Vestry.

London County Council.—The Finance Committee reported at a meeting of the County Council on Tuesday having considered an application from the Shoreditch Vestry for a loan of £67,783 for electric lighting purposes. It appeared that of that sum £11,701 was in respect of buildings, but the Council's architect was able to recommend £13,282 for that item, the increase on the Vestry's figure being for new stores and workshops, the cost of which was under-estimated by the Vestry. The balance of £56,082 was for engineering works, and from that sum the committee had deducted £7,940 for station equipment, and £5,550 for works to mains, as the statements and details produced did not account for those amounts; £4,800 had been deducted for meters, and £3,000 for land and buildings upon which the committee were not yet prepared to report, and £5,664 for street lighting, as to which the committee were not satisfied. On the recommendation of the committee the Council decided to sanction a loan of £42,400. It was also resolved to lend £69,460 to the Islington Vestry for electric lighting purposes.

Hampstead.—The Lighting Committee of the Vestry has recommended that the tender of Messrs. W. T. Glover & Co. be accepted for the supply of electric cables for the next 12 months.

The Lighting Committee is experimenting with incandescent electric lamps of 50 and 100-c.p. for street lighting, as the arc lighting is regarded as not quite satisfactory.

Poplar.—The Board of Works has resolved to instal 20 arc lamps for street lighting at an initial cost of £876, and an annual charge of £384. The Board has also decided to put 25 prepayment meters in use on trial for three months.

North London District.—A conference on the subject of electric lighting has just been held at Tottenham, at which representatives of the District Councils of Edmonton, Enfield, Finchley, Southgate, Tottenham, and Wood Green were present. A resolution was adopted that the local authorities mentioned should enter into an agreement for the promotion of a Bill in the next Parliamentary session to confer powers upon a joint committee to supply electric power. It was also agreed that the appointment of a clerk, engineer, solicitor, and Parliamentary agent should be left to a joint committee. The decisions arrived at by the conference are meeting with a favourable reception from the Councils interested in the matter.

Partick.—The question of a site for the electricity works and refuse destructor has now been disposed of, the opposition having been withdrawn.

Norway.—Messrs. Schuckert & Co., of Nuremburg, have acquired a large calcium carbide works at Hafslund, Norway.

Provisional Orders will be sought for—

Auchterarder.—By the North British Electricity Supply Company.

Brighouse.—By the North British Electricity Supply Company.

Biggleswade.—By the North British Electricity Supply Company.

Chester-le-Street.—By the Chester-le-Street Parish Lighting Company, Limited, which at present uses gas.

Cirencester.—By the United Electric Light and Traction Company. The District Council will oppose.

Dunstable and Houghton Regis.—By Messrs. Garrett & Co.

Newhaven.—By Messrs. Simmons & Simmons. The District Council objects.

Rishton.—By the Blackburn Corporation, and by Mr. C. Chadwell.

Swanage.—By the Bournemouth and Poole Electricity Supply Company.

Pwllheli.—At a meeting of the Pwllheli Town Council held on July 18th, a letter was read from Messrs. Bennett, Ward and Son, Manchester, conveying an offer for the transfer of the electric lighting provisional order which had been obtained by the Corporation of Pwllheli. The Finance Committee of the Council thought that some of the provisions mentioned were high, and after further correspondence Messrs. Bennett, Ward & Son modified the terms of the offer. It was decided that a special meeting of the committee should be convened to discuss the lighting question.

Richmond.—The Electric Light and Power Company have reduced their charges from Lady Day as follows:—For lighting, from 7d. to 6d. per unit; power, from 6d. to 4d.; meter rents are reduced 25 per cent.; wiring is also now done by the company on the hire purchase system.

Rochdale.—An error, which we regret, occurred in our note on Rochdale electricity works last week, when Mr. "T. A. Lacey" was said to be the electrical engineer to the Corporation. Rightly, Messrs. (E. M.) Lacey, Clirehugh & Sillar are the consulting engineers, and the clerk of works is Mr. C. C. Atchison, to whom we are indebted for the correction.

Spain.—Tenders have just been invited for the concession for the electric lighting of the town of Roadabia (Oxense province) during a period of 20 years.

Sunbury.—Last week Mr. Gripper, representing the Twickenham and Teddington Electric Supply Company, had an interview with the District Council with regard to the company's proposed application for a provisional order, and explained the main features of the company's scheme.

Woking.—The directors of the Woking Electric Supply Company, Limited, have issued a notice stating that from and after Midsummer, 1900, the price of energy is reduced as follows:—For any number of units up to 20, 8d. per unit; and for each unit over 20, 7d. It would seem that there is ample scope for reduction!

Wolverhampton.—The electric light is being installed in the Wolverhampton Eye Infirmary by the District Electric Company, to the specifications of Mr. Leonard Stallybrass, electrical engineer, Wolverhampton.

ELECTRIC TRACTION NOTES.

Bath.—The Light Railway Commissioners, represented by Mr. Gerald A. R. Fitzgerald and Colonel Boughey, held an inquiry at Bath on Monday concerning an application made jointly by the Bath Corporation and a syndicate, consisting of Sir James Sivewright and Mr. Leopold Hirsch, for an order to establish a system of electric tramways in Bath and the surrounding districts. Mr. Balfour Browne and Mr. Vesey Knox represented the promoters, and Mr. Lewis Coward the Corporation. The promoters are to establish and run the tramways, paying the Corporation an annual wayleave increasing from £400 to £500, the Corporation having frequent opportunities for purchase. The existing horse trams are to be bought by the Corporation and handed over to the promoters at the same price. The chairman announced that they were prepared to recommend the granting of the order, but the annual wayleave which the Corporation would receive must substantially be spent in effecting street improvements on the routes.

Dublin.—An action was heard last week before the Recorder of Dublin (Sir Frederick Falkinor), for recovery of damages for injuries received. Mr. John Bates claimed £50 from the Clontarf and Hill-of-Howth Tramway Company for breach of duty of defendants in not protecting, managing, and regulating electric wires in the vicinity of Dollymount on May 11th, 1900. Plaintiff was walking with a friend along the road at 8.30 p.m., when he was struck by a telephone wire hanging across the trolley wires, the property of the defendants, and received a severe shock, being thrown violently to the ground. It appeared that there were no guard wires on the poles of the defendant company. The defendants pleaded that the wire which caused the damage was the property of the Telephone Company. The Recorder granted a decree for £8 8s.

Dublin—Howth.—The tramway from Dublin to Howth, 9 miles in length, was opened for traffic on Thursday last week. The route follows the curve of Dublin Bay, and crosses the peninsula of Howth to the East Pier; it is likely to command a heavy traffic, especially during the summer.

Dudley.—A dispute of a very remarkable character has arisen between the representatives of the Dudley Corporation and the British Electric Traction Company. The Corporation has an agreement with the company to take over at valuation in the course of about four years, the whole of the tramlines within the borough now worked by the company. One clause in the agreement provides that the lines shall be constructed and equipped to the satisfaction of the borough surveyor (Mr. J. Gammage). On Saturday last it was discovered that instead of laying the cables in earthenware conduits and setting them in pitch, the Tramway Company's workmen were threading the cables through pipes. Mr. Gammage protested, but the Traction Company's foreman continued the work in spite of all that could be said. Various official negotiations took place, but still the work proceeded. The upshot was that a gang of Corporation workmen were set to fill up the trench which at Scott's Green the tramway men had excavated. The excitement then became great and rapidly developed; as fast as the tramway men pushed forward their cutting, just as fast did the Corporation employés fill it up and batten it down. High words were bandied between the two sets of workmen, and threats of a somewhat sanguinary nature were freely indulged in. Matters were in no way improved when the Tramway Company brought carts on the scene to carry away the dirt thrown from the trench, thus taking from the Corporation men the opportunity of refilling the excavation. As a matter of fact, hostilities did not cease till Sunday afternoon, by which time a large number of carts as well as the Corporation traction engine had been brought into requisition. The traction engine was placed transversely across the tramway company's line of operations, and some of the tramway navvies made an ingenious attempt to upset this cumbrous vehicle. Eventually the tramway officials, acting upon instructions from London, withdrew their workmen, and arrangements were made for a conference between the tramway directors and the Corporation. The tramway officials state that the method on which they have been working was precisely the same as that adopted on the line through Netherton, and was superior to that

on the Stourbridge line, on which the troughs for the cables are of wood. The solid system used in connection with the electric lighting of the borough is, they state, quite unsuitable for tramway work. Mr. Gammage was asked on Sunday why the matter could not have been left to legal arbitrament, and his reply was that an injunction would be applied for at the earliest possible moment. Meanwhile he had deemed it necessary to take other steps.

Hayling Island.—The Earl of Jersey and Col. Bougher, Light Railway Commissioners, attended last week at South Hayling, to inquire into a scheme for constructing a light railway, 2½ miles in length, from the Ferry to East Stoke.—Mr. Wedderburn, Q.C. (instructed on behalf of Mr. Park, a large local landowner, and the trustees of the Park Estate), objected that Mr. Park had not been served with any notice at all, and his name was not even mentioned in the book of reference.—Mr. Bassett Hopkins, Q.C., for the promoters, said Mr. Park's own solicitor (Mr. Chester) was one of the trustees, and he had been expressly served with a notice.—Mr. Wedderburn said although Mr. Chester might have had knowledge of these matters, he had no authority to accept service for Mr. Park.—After a discussion, the Earl of Jersey said the objection was of such a nature that they could not overrule it. It was very important that the rules of the Board of Trade and the conditions of the Act of Parliament should be strictly complied with; but, instead of dismissing the application, they thought the better plan would be for the promoters to make an amended application supplying the deficiencies of the case. It was agreed to adopt this course.

Kingston.—The Light Railway Commissioners, the Earl of Jersey presiding, held an inquiry last week into an application by the British Electric Traction Company for an order to construct electric tramways in Kingston and Surbiton and part of the districts of Esher and Thames Ditton. The application was opposed by all the local authorities concerned and also by the Surrey County Council. After hearing counsel the Commissioners intimated that they could not see their way to grant the order applied for.

Lancaster.—The Tramways Committee, having visited the Tramways Exhibition in London, has reported to the Town Council strongly in favour of the overhead trolley system.

London.—At a meeting of the London County Council on Tuesday, Mr. Mellville Beachcroft, on the motion for the reception of the report of the Highways Committee, asked what was the position of the Council in regard to the veto of local authorities in relation to tramways.

Mr. J. W. Benn, chairman of the committee, stated in reply that he could not speak authoritatively, but he had been informed by the Parliamentary agent that day that the authorities of the House of Commons did not see their way to remove the veto which had been such a serious block to the development of tramways in London. Replying to Mr Leon, the Chairman mentioned that the committee hoped to bring to bear in the immediate future, certain clauses in the lease of the tramways to the North Metropolitan Tramways Company, which would empower the Council to transform that system or parts of it to electric traction.

The Highways Committee submitted proposals for the construction of 28 new tramways or sections of lines, the totals being for 16½ miles on the north of the Thames and 12 miles on the south side of the river. These proposals, an abstract of which is given in another column, were adopted in entirety after a discussion extending over two hours. In a report on the commercial prospects of the tramways the Finance Committee said:—"As regards the longer extensions and new lines, the Highways Committee have been carefully into the question of probable financial results upon reports by the tramways manager as to the probable traffic receipts and working expenses, and by the controller as to the annual debt-charges on the estimated capital outlay. The manager has estimated for traffic receipts at 1s. per mile run and working expenses at 6d., leaving a profit on working of 6d. per mile run. Out of this the debt charges have to be paid. The present traffic receipts on the Council's lines average a little over 10½d. per mile run, and the common experience is that on conversion from horse traction to electric traction the receipts per mile are considerably increased, owing partly to the largely increased passenger accommodation per car, and partly to the improvement in the service. In Glasgow, according to the accounts for the year to May 31st, 1900, just published, the horse-car receipts averaged 11·44d. per mile, while the newly-equipped electrical lines produced 13·87d. per mile. The working expenses in Glasgow for the same year averaged 6·26d. per mile on the electrical lines, giving a profit on working of 7·61d. per mile. The Glasgow figures relate to five miles of double track, and better results may be looked for when the conversion of the whole system has been completed. We think, therefore, that the estimate of 6d. a mile profit on working by electric traction is a safe one, and on this basis the manager's estimates of traffic on the several lines show in total the following result:—

Estimated annual profit on working		£90,061
Annual charge for interest on and repayment of capital outlay—		
Tramways	£56,200	
Street widenings chargeable to tramways ..	£15,490	
		71,630
Estimated annual surplus		£18,431

Norwich.—Colonel Yorke, R.E., of the Railway Department of the Board of Trade, inspected the track of the Norwich Electric Tramways Company on July 26th. Col. Yorke stated that this was the most extensive system that he had yet inspected at one time, and he considered that the scheme had been thoroughly well worked out, taking into consideration the narrowness and crookedness of many of the streets. A few alterations of a minor character were required by the inspector, who said that the Board of Trade would offer no objection to the lines being opened as soon as they had been effected. Mr. Trotter, M.I.C.E., recently inspected the electrical equipment of the tramways, of which our description is concluded in this issue. Traffic commenced on Monday last.

Southampton.—At the last Council meeting, the Tramways Committee having reported the receipt of two letters complaining that the present tram service was unsatisfactory, the Sheriff (Mr. Durnsford) said when they saw there was a jump from 50,000 to 120,000 passengers per week, and there were only 12 cars, they could not be surprised at the Committee's inability to give an efficient service under the circumstances. They had urged on the contractors, but he was afraid they would not have the additional cars which had been ordered for some time.

Warrington.—The promoters of the Warrington and Runcorn Light Electric Railway have withdrawn their application to the Board of Trade for the necessary powers. The scheme will probably be revived in the course of the next few months.

TELEGRAPH AND TELEPHONE NOTES.

Cardiff.—At a meeting of the Public Works Committee last week, Alderman D. Lewis presiding, Mr. Wheatley (town clerk) announced that the National Telephone Company were desirous of re-opening negotiations with the Corporation for the laying down of underground wires. The company had more than once approached them on this matter, but they offered only 2s. 6d. per subscriber, whereas they paid 5s. in one or two other towns. The Mayor (Councillor Brain) said that the Telephone Company were at present in a more accommodating spirit, and would pay 5s. The matter was referred to the borough engineer, with instructions to report upon it fully.

Dover.—Some time ago the National Telephone Company made an application to the Town Council for permission to lay underground telephone wires in certain streets, which the surveyor recommended should be sanctioned. The Committee having determined not to apply for a license, the town clerk was authorised last week to draw up an agreement and submit it to the company.

German Cable to America.—On Wednesday the first German-American cable opened for the transmission of direct messages between Germany and the United States. The line stretches from Borkum to Fayal, one of the Azores, and thence to New York. It is 4,366 nauts in length. The cable was laid by a British company, but was taken over by the German Atlantic Telegraph Company on payment of a sum of nearly two millions sterling. The German Government will subsidise the new undertaking by an annual payment of £140,000 for 40 years on condition that another cable is laid, should the Government consider this advisable. The price per word to New York will be a small fraction over one shilling.

Kingston.—A prolonged struggle is going on between the National Telephone Company and the Corporation of Kingston-on-Thames. The local service is admittedly deficient and the company have laid underground cables between London and the borough boundary on Kingston Hill, but by no sort of manœuvre has the Town Council been induced to consent to the lines being continued underground. Columns of correspondence on the matter have appeared in the local Press, consisting mainly of assertions, denials and rejoinders from the company, the Town Clerk and the Postmaster-General.

London.—At a meeting of the L.C.C. on Tuesday the Highways Committee reported that the appeal of the Council against the order of the judge in chambers, that the action by the Council against the National Telephone Company, to prevent the company placing its works underground without the consent of the Council having been first obtained, should be tried by a special jury, came before the Court of Appeal on July 19th, and was dismissed. The action will therefore be tried by a special jury after the long vacation. On July 24th the information laid by the Post Office against the company was heard before a Divisional Court, when the company consented to an injunction restraining it from breaking up or opening any public thoroughfare within the county of London for the purpose of extending the company's system of underground pipes or conduits, without first obtaining the authority of the Postmaster-General and the consent of the Council, as required by the Telegraphs Act, 1892.

New Cable.—It is stated that the British and Danish Cable Companies are about to lay a cable between Taku and Shanghai.

The Pacific Cable Contracts.—The following appeared in the *Outlook* of the 28th ult.:—"The Pacific cable has at last, thanks largely to the persistent pressure from Canada, reached the tendering stage. At least, invitations to tender are out. But experts, who should know if any one does, say that the Pacific Cable Committee is face to face with an even greater obstacle than any over which it has been puzzling these many weary months. Where, ask these experts, are tenderers for the Pacific cable to get their gutta-percha? The Eastern cable group have seemingly stolen one more march upon the Pacific Cable Committee; they have at least, so it is said

given out orders for something like 14,000 knots *(sic)* of cable. As the result of this and other larger orders, the price of gutta-percha has so jumped up and the sources of production are so chocked that no responsible firm is expected now to give a fixed price or a fixed time for the completion of the Pacific cable. If this be so, what becomes of the Pacific cable and, for that matter, of the foresight and business aptitude of the Pacific Cable Committee? The last day for the reception of tenders is Tuesday, August 14th, and we should therefore soon see these expert assertions put to the test. Meanwhile Mr. Hanbury has informed Sir Edward Sassoon that the Cables of the Empire Inquiry is to be undertaken by representatives of the Board of Trade, the Post Office, the Treasury, the Admiralty, and the India, Colonial, and War Offices. But Permanent Officialdom is too much involved in the cable chaos ever to show the way out. That must be done by open, above-board, searching investigation."

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired
South American:—		
Cayenne-Pinheiro	Oct. 11, 1899	
Pará-Maranham	March 1, 1900	
Ceará-Maranham	Feb. 20, 1900	
Iquique-Valparaiso	July 30, 1900	
Cables south of Serena	July 30, 1900	
West Indies:—		
Jamaica-Colon	June 30, 1899	July 26, 1900
Mole St. Nicholas-Cape Haitien	March 6, 1900	
Latakia-Cyprus	June 20, 1899	
Tarifa-Tangier	Jan. 3, 1900	
Landlines:—		
Chinese:—		
Tientsin-Pekin	June 12, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 30, 1900	
Tientsin, *via* Shanghai	June 16, 1900	
Tientsin-Niuchwang	June 18, 1900	
Shanghai-Chefoo	July 29, 1900	July 30, 1900
South American:—		
Communications with all offices of Columbia beyond Buenaventura	January 23, 1900	
Ecuador landlines	March 13, 1897	
Landlines south of Macahé (Brazil)	April 25, 1900	
Landlines south of Serena	July 30, 1900	
West Indies:—		
Communication with interior of Haiti	July 29, 1900	
Communication "*via* Hanekine" interrupted on Persian territory	Feb. 24, 1900	
Saigon-Bangkok	July 30, 1900	

Trans-African Telegraph.—Reports have arrived from Dar-es-Salaam, dated June 30th, to the effect that all the preparations for laying the African Cape-to-Cairo telegraph as far as Kassanga, in German East Africa, were completed, and that this section of the line would be laid about the end of last month.

Wireless Telegraphy at Sea.—Successful results were attained in the wireless telegraphy experiments conducted by the Northern Squadron on the voyage from Cherbourg to Brest. Communication was maintained between vessels more than 40 miles apart. The previous record in France was 30 miles.

The Belgian Government have decided to instal Marconi's wireless telegraphy installations on their cross-Channel mail packets, running from Ostend to Dover. Experiments have been conducted between the ships and the shore over long distances with most satisfactory results. The distance from Ostend to Dover is 68 miles, and the vessels will communicate with the nearest port, which will only be 35 miles away at the most.

The South-Eastern and Chatham and Dover Railway Company made arrangements some months ago with Marconi's Wireless Telegraph Company for the installation of the latter's apparatus on their boats running between Dover and Calais, but, says the *Daily Mail*, the General Post Office prevents it from being carried out.

Weedon.—The Post Office telegraph and telephone testing station and stores at Weedon were ignited by lightning on Friday night, but, the alarm being quickly raised and 100 soldiers from the barracks speedily arriving, the fire was soon extinguished. The delicate and expensive testing apparatus was seriously damaged, and a number of the main line wires, of which 172 pass through the station, were fused. The Post Office electricians residing at Weedon began at once to rejoin the wires, and, by connecting them outside the station instead of running through it, all communications were restored by daybreak the next morning.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aarhus, Denmark.—The municipal electrical works are wanting "200 pieces electro-meters." For particulars see "Official Notices" July 20th.

Accrington.—The Corporation wants tenders for the supply of electricity meters. See "Official Notices" to-day.

Belfast.—August 15th. The Electric Committee wants tenders for an auxiliary feed-water heater and piping. See "Official Notices" July 27th.

Blackburn.—August 6th. The Corporation wants tenders for a traction switchboard. See "Official Notices" July 27th.

Bradford.—August 13th. The Guardians of the Bradford Union want tenders for the electric lighting of the workhouse. See "Official Notices" July 27th.

Brussels.—September 19th. The Council of St. Jilles, lez Bruxelles, invites tenders for the installation and the commencement of supply upon a part of its territory. Conditions and plan for three francs at the office, No. 14, Parvis St. Jilles, St. Jilles.

Budapest.—October 15th. The Hungarian Minister of Commerce is prepared to receive tenders for the installation of two telephone exchanges, local and interurban, complete in all respects. See "Official Notices" to-day.

Dorking.—The District Council are open to receive offers for leasing their provisional order. See "Official Notices" July 20th.

Edinburgh.—August 13th. The Corporation wants tenders for coal-conveying machinery for Dewar Place station. See "Official Notices" to-day.

Germany.—September 10th.—The Hamburg Finance Deputation is inviting tenders for the supply and erection of two 30-ton electric cranes. Particulars may be obtained for 3s. from the Secretariat II. der Finanz Deputation (Rathhaus Ober-Erdgeschoss, Zimmer 429), and tenders marked 339 are to be sent to Die Finanz Deputation, Hamburg.

Grays Thurrock.—August 9th. The Council is inviting tenders for Lancashire boilers, 100-kw. steam dynamos, economisers, switchboards, battery, crane, mains, and other plant, &c. See "Official Notices" June 29th.

Grimsby.—August 8th. The Corporation wants tenders for wiring the electricity works. See "Official Notices" July 20th.

Grimsby.—August 18th. The Corporation wants tenders for the supply of a steam engine and dynamo, and extension of switchboard. See "Official Notices" to-day.

Halifax.—Tenders are invited by the Town Council for mechanical stokers. See "Official Notices" July 27th.

Halifax.—The Corporation wants tenders for the supply of incandescent lamps. See "Official Notices" to-day.

Leeds.—The Corporation wants tenders for the purchase of second-hand machinery, at present in use in connection with the electric tramways. See "Official Notices" to-day.

London.—August 14th.—The South London Electric Supply Corporation, Limited, invites tenders for condensing plant and cooling tower. See "Official Notices" to-day.

London.—August 20th. The Central Electric Supply Company wants tenders for boilers and piping, and mechanical stokers. See "Official Notices" July 27th.

Luton.—September 14th. The Town Council invites tenders for watt-hour and demand meters. See "Official Notices" to-day.

Madrid.—August 18th. Tenders are invited by the Spanish Government, not later than August 18th, for the concession of a system of electric tramway lines in Barcelona. Some particulars may be examined at the commercial department of the Foreign Office between 11 a.m. and 5 p.m.

Newcastle-on-Tyne.—August 22nd. The Corporation wants tenders for laying five miles of double-line tramway. See "Official Notices" to-day.

Russia.—August 28th. The General Direction of the Russian Posts and Telegraphs in St. Petersburg are inviting tenders until August 28th for the concession for the working during a period of 68 years of the telephone exchanges in St. Petersburg, Warsaw, Riga, Moscow, and Odessa.

Salford.—August 13th. The Corporation wants tenders for lighting cables, tramway feeders, and street lighting. See "Official Notices" July 13th.

Spain.—August 10th. Tenders are being invited until August 10th by the municipal authorities of Mogner (Hullva province), for the concession for the electric lighting of the town during a period of 20 years. Particulars can be obtained from, and tenders are to be sent to El Secretario del Ayunlamento de Mogner (Hullva).

Stockport.—August 31st. The Tramways Committee wants tenders for 20 double-deck tramcars with electrical equipments. See "Official Notices" July 13th.

The Pacific Cable.—August 14th. Tenders for the manufacture and laying in the Pacific Ocean of 8,272 nautical miles of telegraph cable are invited by the Pacific Cable Committee on behalf of Her Majesty's Government and the Governments of Canada, New South Wales, Victoria, New Zealand, and Queensland. See "Official Notices" July 20th.

Torquay.—August 6th. Tenders are wanted by the Corporation for two water-tube boilers with superheaters, two inductor alternators with Willans engines, pipework, surface condenser, extensions to high tension switchboards, wattmeters, &c., and transformers. See "Official Notices" July 20th.

(*Continued on page* 188.)

GLOUCESTER ELECTRICITY WORKS.

The history of the electric light question in Gloucester dates from June, 1889, when four companies gave notice of their intention to apply to the Board of Trade for provisional orders authorising them to supply electricity within the district of the city of Gloucester. A report was then prepared explaining the various courses open to the Council, and it was decided not to consent to the application of any company, but to obtain further information and consider whether or not the Council should itself apply for such a provisional order.

Notices were given by three companies in 1890, by one company in 1891, and by two companies in 1894, but no further proceedings were taken by any of the companies.

In 1895 one company again gave notice, and proposals were made by the City of Gloucester Tramways Company, Limited, for a combined scheme for electric lighting and traction.

On November 12th, 1895, the Corporation decided not to consent to the application of any company, and resolved, with one dissentient, to apply for a provisional order authorising the Corporation to supply electricity for public and private purposes within the city, and the application was granted by the "Gloucester Corporation Electric Supply Order, 1896," confirmed by the Electric Lighting Orders Confirmation (No. 1) Act, 1896.

In June, 1897, the Council consulted Mr. Robert Hammond, M.I.C.E., and instructed him to prepare a preliminary report dealing generally with the question of electricity supply for lighting and other purposes, and with the question of providing a refuse destructor.

In August, 1897, after considering Mr. Hammond's report, the Council unanimously decided to establish electricity works, with a refuse destructor in connection therewith, and engaged Mr. Hammond to prepare a scheme on the lines suggested in his preliminary report, and afterwards to prepare plans and specifications for, and superintend the carrying out of the work.

At first much difficulty was experienced in finding a suitable site, but that question was happily solved by the Corporation purchasing the Bearland Estate and adjoining properties as an investment for corporate funds, and obtaining the sanction of the Local Government Board to use a portion of the property as a site for the electricity works. A most excellent site has thus been acquired in a central position, easy of access, and near to the river, canal and dock branch railway.

Following is a list of original contracts:—

Buildings	John Gurney & Sons, Gloucester.
Boiler house plant	Yates & Thom, Blackburn.
Engine room plant	India-Rubber Company, Silvertown.
Condensing plant	Blake & Knowles Steam Pump Company, London.
Pipe work	Ashton, Frost & Co., Blackburn.
Condensing water pipes ...	Stanton Iron Works Company.
Travelling crane	Jas. Spencer & Co., Hollinwood.
Switchboard and instruments	Crompton & Co., Chelmsford.
Accumulators	Electrical Power Storage Company, London.
Mains	Callender's Cable and Construction Company, London.
Public arc lamps	Brockie-Pell Arc Lamp, London.
Meters	Chamberlain & Hookham, Birmingham.
Refuse destructor	Heenan & Froude, Manchester.

The site of the generating works is in the south-west part of the city and the buildings are constructed of brick with Bisley stone dressing.

Electricity works do not naturally lend themselves to elaborate and architectural adornment, and no attempt has been made at unnecessary ornamentation, but the architect has, nevertheless, produced a structure which does credit to his profession. The whole of the building work has been carried out by the local firm of Messrs. John Gurney & Sons.

In planning the buildings, care had to be taken to allow ample room for future extensions, and to plot them in such a way that the refuse destructor, for which contracts have just been let, should form part of the same building. The natural formation of the site admirably adapts itself to what is required for the destructor. A level roadway will run from Ladybellegate Street to the charging floor, which is 15 feet above the clinkering floor, the latter being on the same level as the ground floor of the present buildings.

The works are approached both from Commercial Road and Ladybellegate Street. The buildings, which were designed by Mr. Harry A. Dancey, of Gloucester, consist of a lofty engine room and boiler house, and a well-arranged suite of offices. The engine room is 54 feet × 37 feet, and 28 feet high. The interior walls are executed in buff bricks with a dado of brown glazed bricks, finished with a moulded capping. In the north-west corner of the engine room is the condenser pit, the floor of which is 12 feet below the engine room level. Running along the south side of the engine room is the switch room, and immediately behind this is the test room. The level of these two rooms is 4 feet higher than the floor of the engine room. This enables the switch board attendant to obtain a good view of all the machinery. The boiler house runs parallel to the engine room, and is of slightly larger dimensions. It provides space for four boilers, and also contains the pump house and economiser.

The chimney stack is an imposing structure, 150 feet high, with an internal diameter which is nowhere less than 6 feet.

The boiler house contains three Lancashire boilers, by Yates & Thom, of Blackburn. Each boiler is 30 feet long by 8 feet in diameter, capable of evaporating 6,000 lbs. of water per hour. They are made of steel throughout, and are constructed for a working pressure of 160 lbs. per square inch. The shells are composed of seven rings, each made from one plate $\frac{3}{8}$-inch thick.

The boilers are fitted with Proctor's mechanical stokers. The dampers in the side flues are worked from the front end of the boilers, the balance weights being arranged to work in guides, which are graduated to show the opening in inches and feet.

Water is fed into the boilers by a compound double-acting ram pump, made by Evans, of Wolverhampton, with an injector as stand-by, and the feed water can be passed directly into the boilers, or alternately through a feed heater and a Green's economiser, containing 192 tubes. A Bruce-Peebles 5-KW. shunt-wound motor, placed outside the pump house, drives the shafting for the mechanical stokers and the scrapers for the economiser.

The main steam and feed pipes are of lap-welded steel, and the whole of the pipework was entrusted to Messrs. Ashton, Frost & Co., Limited, Blackburn.

The generating plant at present at work consists of two combined sets. The larger set is composed of a triple expansion engine, with one high and two intermediate cylinders placed above three low pressure cylinders, working on cranks set 120° apart. The engine runs at a speed of 350 revolutions per minute, and is designed to give 500 indicated horse-power, with 160 lbs. steam pressure. To this engine are coupled two Silvertown dynamos, the two being capable of giving an output of 300 KW. at any pressure between 440 and 500 volts. The dynamos are of the single horseshoe type, with drum bar armatures and shunt-wound magnets.

The smaller engine is a two-crank compound engine, with one high and one low pressure cylinder, working on cranks set 180° apart, the steam being distributed by a single piston slide-valve of special design placed between them. This engine runs at a speed of 380 revolutions per minute, and will give 250 indicated horse-power, with 130 lbs. of steam. The engine drives two Silvertown dynamos having a combined capacity of 150 KW., at any pressure from 440 to 500 volts, these machines being of the same type as those of the larger set. The engines, which were made by Messrs. Belliss & Morcom, Ltd., of Birmingham, are fitted with their patent system of forced lubrication. In this system a small pump worked off the main shaft supplies oil under pressure to a series of pipes which convey the oil to each bearing and ensure every working part being thoroughly lubricated. By this means the engines are enabled to make uninterrupted runs for long periods without any undue consumption of oil. The design, truth of workmanship, and accuracy of adjustment of the plants are of the highest class, and permit of the engines running quietly and without trouble at the high speed at which they work.

A booster is placed in the engine room, and provides the necessary additional pressure for charging the battery. It

consists of two single horseshoe undertype machines coupled together and mounted on the same bed-plate. One machine runs as a motor, and obtains current from the bus bars at 220 to 250 volts. It drives the other machine, which is a generator, and is designed to give a current of 100 amperes at any pressure from 20 to 150 volts when running at a speed of about 780 revolutions.

In the condenser pit, the Blake & Knowles Steam Pump Company have erected two of their well-known jet condensing plants. Each of these is capable of dealing easily with 10,000 lbs. of steam per hour, and of maintaining a vacuum of 26 inches under all normal conditions of atmospheric pressure.

An overhead travelling crane spans the engine room. It was made by Messrs. Spencer, of Hollinwood, and will lift a weight of 10 tons.

On a gallery running along one side of the engine room is placed the switchboard. It is composed of nine enamelled slate slabs fixed in a wrought-iron frame, which rests on a plinth of glazed bricks. The slates are insulated from the iron frame by ebonite bushes and washers, and the uprights of the framework are hidden by a polished brass beading, which gives a very neat appearance to the board.

The switchboard is divided into three parts: the positive on the right, the booster and battery switches and instruments being in the centre, and the negative on the left.

On the positive side are mounted the two minimum automatic cut-outs, shunt regulating switches, and shunt breaking switches for the dynamos, as well as their duplex fuses and 2-way switches.

In circuit with each dynamo is a Crompton shunted type ammeter, and a Crompton dead-beat voltmeter is common to the two machines, the switch being placed below the voltmeter.

At the top of the board are placed the six sets of feeder gear, which consists of an ammeter, a 2-way switch with a quick-break action for disconnecting the circuit, and a duplex fuse.

The negative side of the board is similar in every respect.

The centre panel contains all the switches for operating the booster. Above these are placed hand wheels which are geared to the battery switches, which are placed in the battery room over the switchboard. Each hand wheel is surrounded by the numbers of the contacts on the battery switch, and the gear is so arranged that for each complete turn of the wheel the battery switch is moved on to a new contact, the number of which is indicated by a pointer moving to the corresponding number on the front of the board.

In circuit with the earth connection from the middle wire an automatic device has been fixed off the board. It is manufactured by Messrs. Crompton & Co., and is of the same construction as their well-known type of automatic cut-out. It is so arranged that as soon as the current to earth exceeds 10 amperes, the ammeter is short-circuited, leaving a direct connection from the middle wire to earth. There is an interlocking arrangement on the switch, which prevents the ammeter being put into circuit until the current to earth has again fallen below 10 amperes. The dynamos and the booster are connected to the board by means of india-rubber lead-covered cables drawn into Doulton casing, and the battery is coupled up by ½-inch copper rod run on insulators, which are suspended on wrought-iron straps from the roof.

The whole of the switchboard work, and the cable and copper connections, have been carried out by Messrs. Crompton & Co., of Chelmsford.

The battery consists of 280 K.W.S. type cells, manufactured by the Electrical Power Storage Company, Limited, and is capable of maintaining a discharge of 80 amperes continually for 10 hours. The containing boxes are of wood, lead lined, each cell containing 30 plates separated by glass tubes held in place at the top and bottom, and the cells are placed on 2-tier stands with iron standards and wood bearers. The approximate weight of each cell, complete with acid, is 435 lbs.

Callender's Cable and Construction Company were entrusted with the important part of the conductors, the mains being laid on the "solid" system. Briefly, this method may be described as follows:—In the trench, square cast-iron troughs are laid, into which, at intervals of about a foot, are placed wooden bridge pieces for supporting the cable. A clearance all round the cable is thus provided, so that when bitumen is poured into the trough it flows all round the cable. Over the troughs are laid cast-iron covers.

For the private supply the electricity is conveyed from the generating works to various parts of the city by six "feeder" cables, which, as their title implies, feed the network of cable that distributes the current amongst the consumers. The five principal "feeders" are of ·4 square inch section, the other being ·25 square inch. By the side of each feeder a three-core $\frac{7}{20}$ "pilot" cable, lead-sheathed and armoured, is laid direct in the earth, and runs from each feeding point to the main switchboard at the generating works.

The distributing mains form a complete network of cables of various sizes, and are joined up to the feeders in Callender's disconnecting boxes. From the distributors service lines are run to each consumer. All the feeders and distributors are triple-concentric, lead-sheathed cables, which are further protected by the bitumen compound in the cast-iron troughs.

The cable used for conveying the energy to the public street lamps is a $\frac{7}{16}$ single lead-sheathed conductor laid direct in the ground. Each section of the public lighting cable is connected at suitable points to the network.

The total amount of cable laid up to the present is as follows:—

Feeder cables	3¾ miles.
Pilot cables	3¾ „
Distributor cables	12½ „
Public lamp cables	3¾ „
Total	23¾ miles.

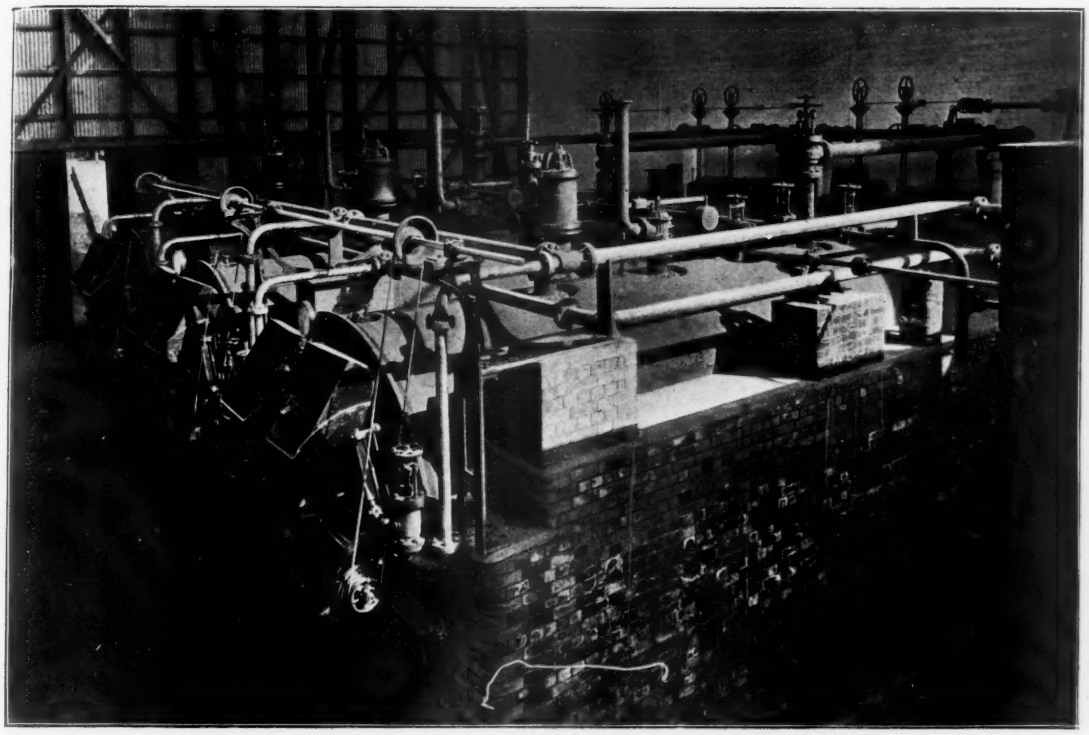
At the present there are 44 arc lamps in use for the street lighting, these being grouped in four series of nine lamps each, and two of four lamps, and supplied with electrical energy from the distributing network. The lamps are the Brockie-Pell single carbon type, and are erected on posts supplied by Messrs. Hardy & Padmore, of Worcester. Each lamp is provided with an automatic switch, which inserts a substitutional resistance if the circuit in the lamp be broken. For trimming and repairs the lamps are lowered by means of a winch fitted in the base of the pillars.

Gloucester has a population of about 42,000. The refuse is collected from 9,000 houses three times per week on alternate days, and averages 25 tons per day, or 150 tons per week of six working days. The City Council desired to thoroughly cremate this without causing a nuisance, and in such a manner as to utilise the heat in raising steam for the electricity works.

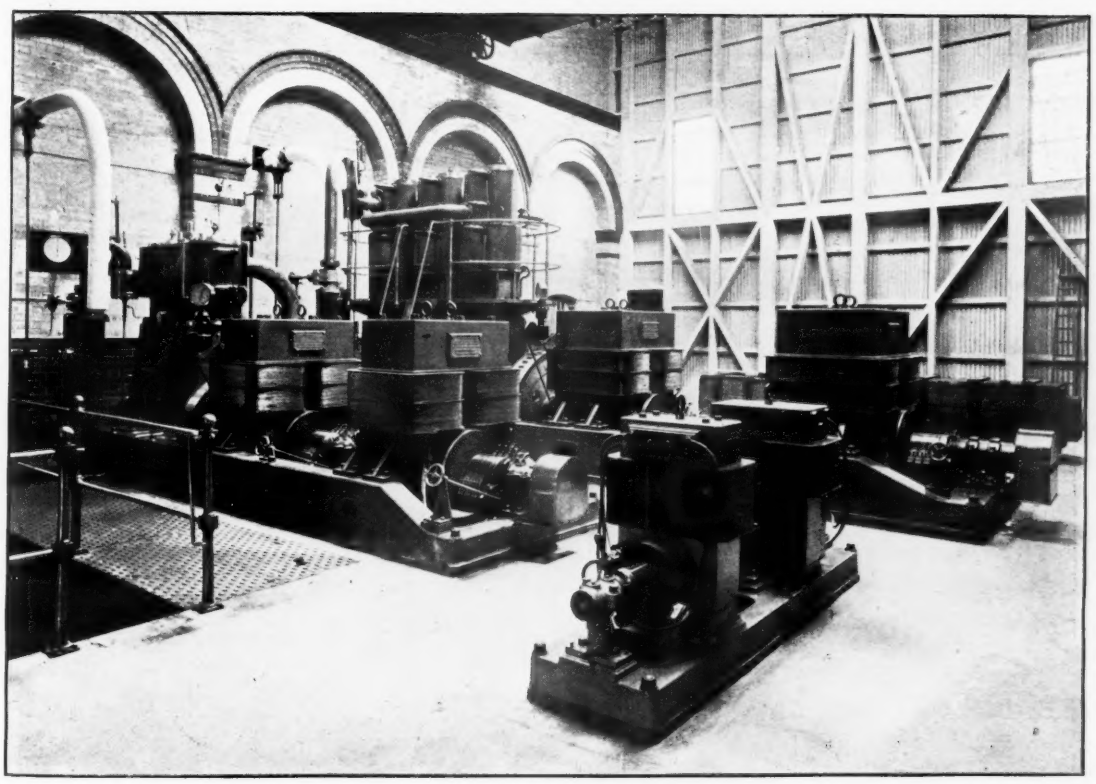
Among the various plans submitted, in response to the advertisement for tenders, it appeared that the twin-cell destructor of Messrs. Heenan & Froude best fulfilled these conditions, and accordingly the contract was allotted to them. The destructor, having a burning capacity of 50 tons per 24 hours, will consist of two cells side by side, only separated from each other by a low bridge like that at the back of a boiler, so that an open communication exists between the two cells. Each cell will have a charging door on one side of the furnace, corresponding to the clinkering door on the opposite side, and the combustion chamber will be placed above the two cells, extending the whole length of them, the boiler being fixed above the combustion chamber. The feeding will be done through a hopper provided in connection with each charging door, so that the refuse may be put straight on to the grate bars, and the men on the clinkering side can also pull it forward, if necessary, so that there will be a direct course either by pushing from the charging door, or pulling from the clinkering door to get the refuse into the grate.

The blast will be fed to the underside of the ashpit, the grate being supplied with air blast by a fan; the steam blast by a jet—the whole under entire control. The main feature of the destructor is, that by simply altering the direction of a damper the gases from either grate can be alternately made to travel over the hot fire in the other grate, and so into the combustion chamber, and finally into the boiler. The whole apparatus will be compact and close together, without any long flues for loss of heat before reaching the boiler. Charging and clinkering will take place alternately, first with one cell and then with the other, so that there will be always a hot fire in the one cell to cremate the smoke and fumes

from the other. A water-tube boiler having 1,300 feet of heating surface will be provided over each of the two pairs of cells. These will be complete with all the necessary fittings and pipework, enabling them to work in conjunction with the electricity works boilers for supply of steam to the electricity works engines. The level of the tipping platform will correspond with that of Ladybellegate Street, whence the refuse carts will enter the works, consequently the approach roadway will be a level one on an inclined ground, so reversing the more usual order. The portion of this roadway opposite the electricity works boiler house will be partly of girder construction, so that the space below can be used for coal storage and bunkers. Ample space is allotted for the clinker cooling yard.



Boiler House.



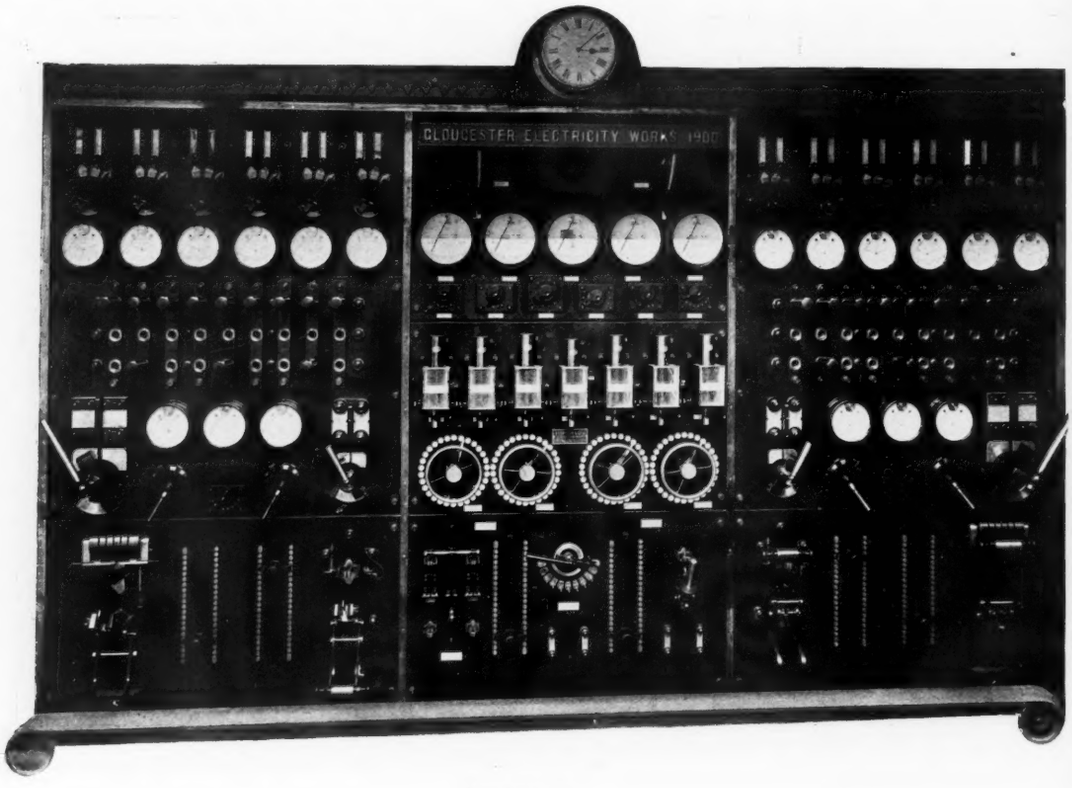
General View of Engine Room.

F

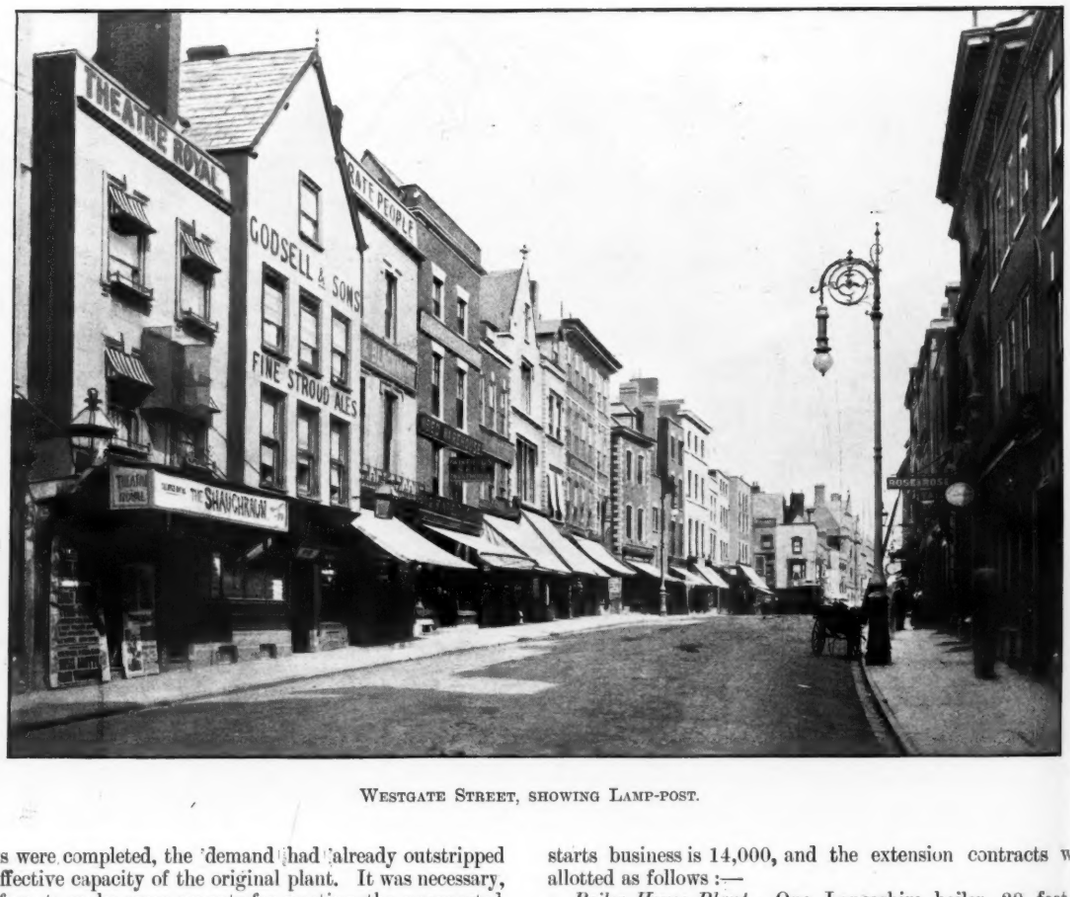
As soon as the work of laying the mains was begun, a great demand for electricity was made upon the Corporation by intending consumers, with the result that, before the works were completed, the demand had already outstripped the effective capacity of the original plant. It was necessary, therefore, to make arrangements for meeting the unexpected large requirements, and extensions of the works had to be undertaken before the original plant had been got into use.

The total number of lamps with which the undertaking starts business is 14,000, and the extension contracts were allotted as follows :—

Boiler House Plant.—One Lancashire boiler, 30 feet ×

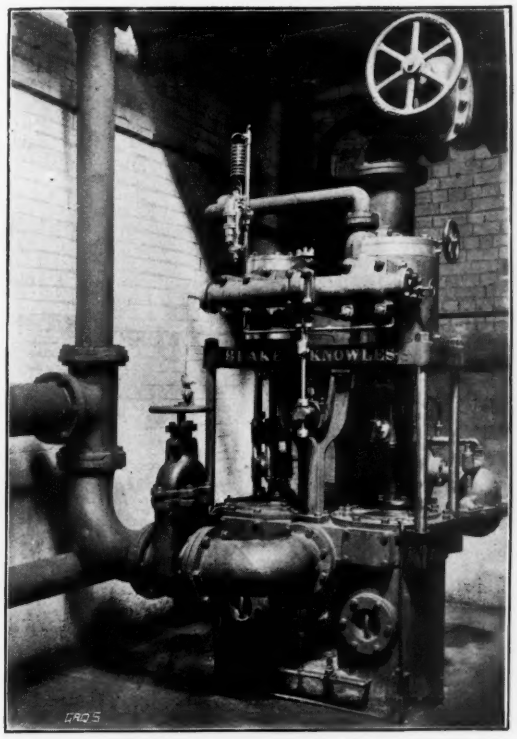


Switchboard.



Westgate Street, showing Lamp-post.

8 feet 6 inches, capable of evaporating 8,000 lbs. of water per hour. It is fitted with Proctor's mechanical stokers.



Condensing Plant.

The contract was given to Messrs. Tinkers, Limited, of Hyde.

Engine House Plant.—This was supplied by Mather and Platt, of Manchester, and consists of a Willans & Robinson 500-H.P. triple expansion central valve engine, running at 320 revolutions, coupled to two 150-KW. shunt wound dynamos of Mather & Platt's manufacture.

Switchboard.—The extensions to the switchboard were put into the hands of Crompton & Co., the makers of the original board.

Condensing Plant.—One jet condenser, capable of dealing with 10,000 lbs. of steam per hour. This was supplied by Ed. Chester & Co.

Class of premises.	Number of hours lamps are used.		Average charge per unit consumed during the year.	Annual cost of electric lamps and ordinary gas burners giving 8 C.P.		Annual saving on each 8 C.P. lamp by use of electricity.
	Average per day.	Total per annum.		Electric lamp.	Ordinary gas burner with gas at 2s. 6d. per 1000 c.f.	
				s. d.	s. d.	s. d.
Offices, &c.	1	365	7d.	6 4	3 6	—
Early-closing shops	2	730	4¾d.	8 8	7 1	—
Other shops	3	1,095	3·8d.	10 4	10 11	7
Dwelling houses, &c.	4	1,460	3·4d.	12 2	14 6	2 4
Hotels, restaurants, and public houses	5	1,825	3·1d.	14 2	18 3	4 1
Clubs and billiard rooms	6	2,190	2·9d.	15 11	21 10	5 11
	7	2,555	2·78d.	17 9	25 7	7 10
	8	2,920	2·68d.	19 7	29 2	9 7
Outside lamps, dark business premises and basements.	11	4,015	2·50d.	24 11	40 1	15 2
	24	8,760	2·23d.	48 10	87 5	38 7

N.B.—The above figures do not include the cost of renewing lamps, but a lamp (costing 1s.) will burn about 2¾ hours a day for a year. On the other hand no allowance has been made in respect of the great saving that may be effected by the use of suitable switching arrangements for turning off the light when not required, or in respect of the periodical saving in the cost of decorating premises and other advantages resulting from the use of electricity.

After very careful consideration, the Corporation decided to adopt a sliding scale system of charging, whereby the price of electricity to any consumer will be regulated by the length of time during which the supply is used.

The scale of charges has been fixed as follows:—7d. per unit for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand recorded by the demand indicator. (N.B.—By "maximum demand" is meant the largest quantity of electrical energy *in actual use at some particular time* during the quarter.) 2d. per unit for all consumption during the quarter beyond the above.

The object of this sliding scale of charges is to provide for the payment by each consumer of the due proportion of the charges which are involved in laying down and always keeping ready the necessary plant for the supply of the full amount of electrical energy which the consumer may at any time demand.

The preceding table gives a useful comparison of the cost of electric light and gas in Gloucester.

For motive power the following rates have been adopted:—4½d. per unit for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand recorded by the demand indicator; 1½d. per unit for all consumption during the quarter beyond the above.

That this is an extremely favourable rate to the consumer will be seen from the following table:—

For a use of	The average price per unit will be
1 hour per day of the maximum demand ...	... 4·5d.
2 hours " " " ...	... 3·15d.
4 " " " " ...	... 2·32d.
6 " " " " ...	... 2·05d.
12 " " " " ...	... 1·77d.

NORWICH ELECTRIC TRAMWAYS.

(*Concluded from page* 147.)

The indicator diagrams which we reproduce were taken from one of the main generating sets at full load; the following particulars apply to them:—Steam pressure,

Theatre Street, Norwich.

130 lbs. per square inch; speed, 198 revolutions per minute; I.H.P. high pressure cylinder 152, low pressure cylinder 178,

total 330 H.P.; pressure, 550 volts; current, 392 amperes; E.H.P. 289.

From these figures it will be seen that the combined overall efficiency at full load is 87½ per cent., a remarkably good result. The set is capable of running safely for three hours with an overload of 50 per cent.

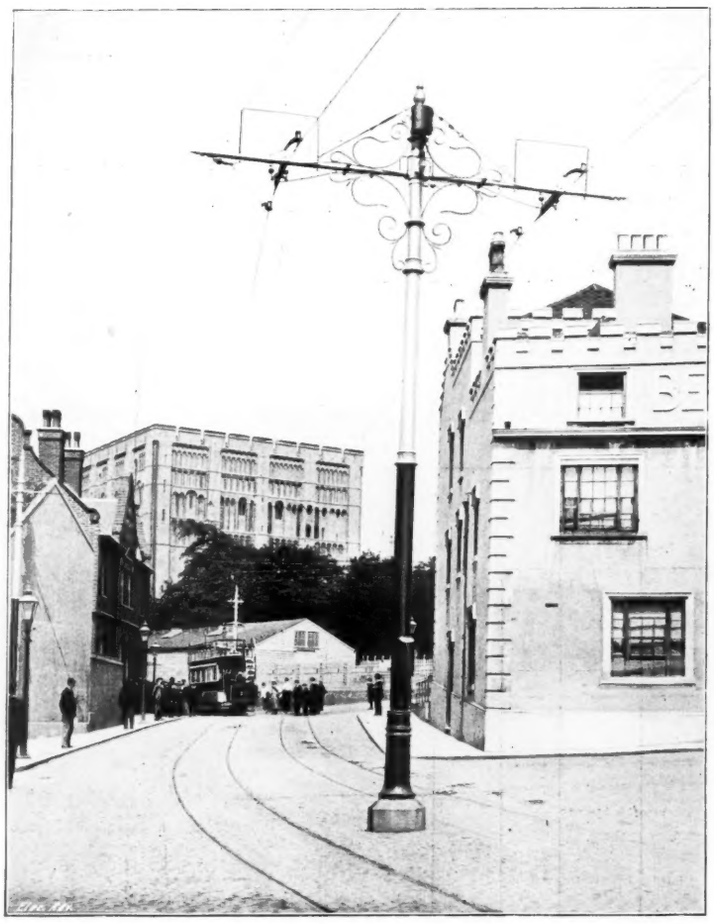
Owing to the central situation of the power station, no very long feeders are required: nearly all of them are 0·24 square inch cross-section. They are single-core lead-covered cables, of the British Insulated Wire Company's make, and are drawn into earthenware conduits, supplied by Messrs. Doulton and Co., Limited. The conduits are for the most part laid in the solid concrete bed underlying the tramway tracks. Test and telephone wires are also used, drawn into 2-inch earthenware tubes. Switch pillars are provided at suitable points, into which the feeder and test cables are taken, and the connections are so arranged that any section of the trolley wire can be fed by two different feeders.

The track return feeder consists of six old steel rails in parallel, laid so as to break joint, and bonded together.

The accompanying map shows the routes followed by the various lines, which radiate outwards from a point near the centre of the area, and close to the ancient castle. The company's offices will be situated within a triangular space formed by the tramways to the south of the castle, at the junction of Red Lion Street with Little Orford Street and Castle Meadow.

The length of track already completed amounts to 19¼ miles, part single and part double; the total length of the various routes is 14 miles. Double trolley wire is employed throughout, with all kinds of suspension.

Red Lion Street.



Orford Hill, with View of Castle.

The trolley wire is 0·32 inch diameter, and was made by Messrs. Roebling; almost the whole of the overhead work was carried out by Messrs. R. W. Blackwell & Co., including the supply and erection of the poles. Where bracket suspension is used, the insulators are carried on the flexible harp device designed by Mr. Winslow, which we described and illustrated in connection with the Coventry Electric Tramways (Electrical Review, February 2, 1900). A good example of this, and of a centre pole, is shown in our view of Orford Hill. This figure also shows the method adopted to relieve the stress on a section insulator, by means of small pull-offs; a lightning arrester is fixed near the top of the pole. Aetna insulation is used throughout.

The construction of the track is shown by the cross-section which is given on a later page; the foundation of the way consists of a bed of concrete 6 inches thick, in which steel sleepers, 5 feet long and weighing 40 lbs. each, are laid at intervals of 10 feet. The rails are in 45 feet lengths, and weigh 65 lbs. per yard; they are clipped to the sleepers at a gauge of 3 feet 6 inches, and are stayed by tie rods 10 feet apart, passing through the rail near the top of the web.

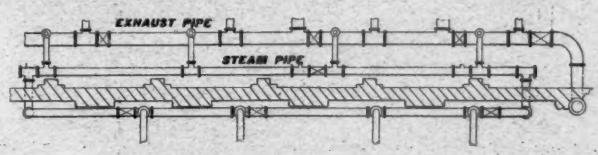
The whole of the joints were made on the Falk cast-weld system by Messrs. Blackwell & Co.; the rails are cross-bonded at intervals of 200 feet with 0000 Crown bonds.

Owing to the narrow and crooked nature of the streets, there are numerous sharp curves, the smallest being no more than 35 feet in radius; there are also several steep gradients, up to 1 in 12, an example of which was shown last week in our view of the hill at the Guildhall, an interesting old building faced, like many others of the ancient edifices

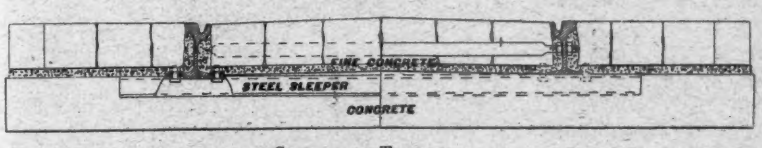
which abound in Norwich, with dressed flints. In many places it was found impossible to construct suitable curves within the limits of the existing roadways; where this occurred, the frontage line of the street was set

Red Lion Street before Widening.

back, or a corner house removed, in order to make room for the tramways. In other cases it was necessary to widen a street for the whole of its length, as in Red Lion Street,



Arrangement of Steam and Exhaust Pipes.



Section of Track.

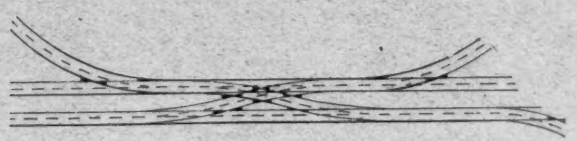
views of which as it used to be, and as reconstructed, with a car on the line, are included herewith. Several instances occurred where it was deemed expedient to cut new thorough-

Orford Hill, as it was.

fares, and, in fact, as the main street of Norwich was too narrow to admit a tramway, and the land too valuable to allow of widening, two new streets were built parallel with the main street, and equipped with tramways.

A typical example of this procedure is seen in our views of Orford Hill; before the advent of the Tramway Company, the centre of this view was occupied by a building, which completely obscured the castle, now seen to great advantage in the background through the new cutting. We give also a view of Theatre Street—a route which will not be regularly used, but is intended to provide a relief or alternative route to certain others—to illustrate the straitness of the way—in one place only 12 feet 6 inches between the kerbs! There is, of course, insufficient room for two cars to pass at the point referred to.

The frequent changes necessary from single to double track

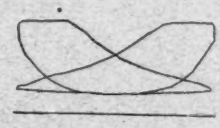


Special Work at the Royal Hotel.

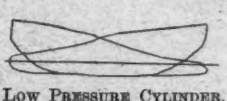
called for an unusually great amount of special work; one example of this, a "scissors" crossing at the Royal Hotel, is illustrated. Much of this work was carried out on a novel plan; the rails were shaped to suit the crossings, and then welded up solid in place with the cast-weld apparatus. So far as can be judged at present, the result is quite satisfactory.

All the points, both automatic and movable, were supplied by Messrs. Askham Bros. & Wilson.

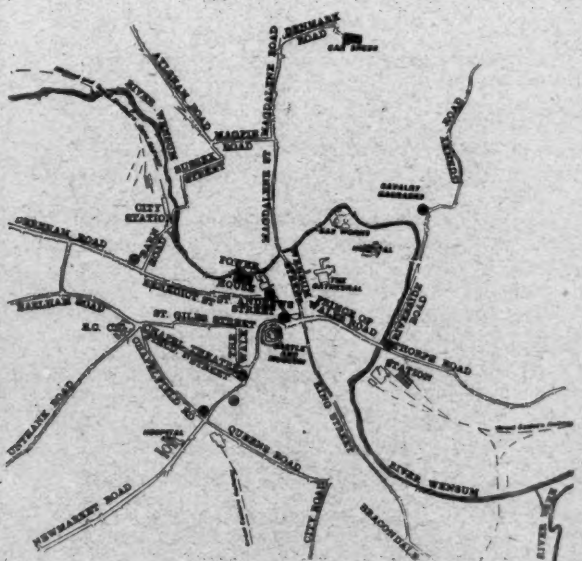
The rolling stock consists of 40 motor cars, carrying 52



High Pressure Cylinder.



Low Pressure Cylinder.
Diagrams from the Main Engines.



All the routes shown are equipped with tramways.

Map of Norwich Tramways.

passengers each, and 10 trailers, carrying 40 passengers, all the cars being of the double-deck type. The former are equipped with two Westinghouse No. 46 motors, each of 20 H.P., and

Westinghouse controllers. The Winslow trolley standard, with inside springs and straight underrunning trolley wheel, is used on the cars; this also was dealt with in our Coventry article. The trucks are of the standard "Peckham" type.

The car depôt, which is situated at the terminus of the Magdalene Street route, besides providing accommodation for the cars, includes a repair shop 60 feet square, equipped with a 2-ton travelling crane, an emery car-wheel grinder, three lathes, three drill presses, a power hack saw, universal milling and wood-working machines, hydraulic wheel-press, morticing machine, band saw, &c. With this very ample equipment of machine tools, which are driven by a Westinghouse motor, all kinds of repairs can be carried out on the premises. All the works in connection with the tramways have been carried out by Messrs. Pauling and Co., of Westminster, assisted by the various sub-contractors mentioned.

From what we have said, it will be seen that the whole undertaking has been carried out in a most energetic and thorough manner; no half-hearted experimental work, "to see whether it will pay," has been the order of the day at Norwich. Extraordinary difficulties have been met with and overcome, and that in a very short space of time; while, far from disfiguring the city, it cannot be doubted that the tramways have already been the cause of great improvements, and will be, in the future, of immense benefit to Norwich.

The lines were finally inspected last week by the Board of Trade inspector, and running was commenced on Monday last. We heartily congratulate Mr. Winslow, chief engineer of the New General Traction Company, and Mr. Bannister, engineer of the Norwich Electric Tramways Company, who have designed and supervised the carrying out of all works in connection therewith, on the completion of this important undertaking.

We have pleasure in tendering our best thanks to Mr. Winslow for providing us with the necessary particulars for the preparation of this article, and to both Mr. Winslow and Mr. Bannister for their courteous and untiring assistance on the occasion of our recent visit to Norwich.

CONTRACTS OPEN AND CLOSED.

(*Continued from page* 180.)

Portsmouth.—September 4th. The Corporation wants tenders for the complete equipment of the tramway power station. See "Official Notices" to-day.

Warrington.—The Corporation wants tenders for electric light installations in certain buildings. See "Official Notices" to-day.

Warsaw.—August 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Acting Consul-General at Warsaw stating that tenders are invited by the Russian Government, not later than the 28th prox., for the telephone service of Warsaw, St. Petersburg, Moscow, Odessa, and Riga Some particulars may be examined at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

CLOSED.

Epsom.—The District Council has accepted the tender of Mr. T. G. Minter, Westminster, at £4,551, for the erection of the electric lighting station.

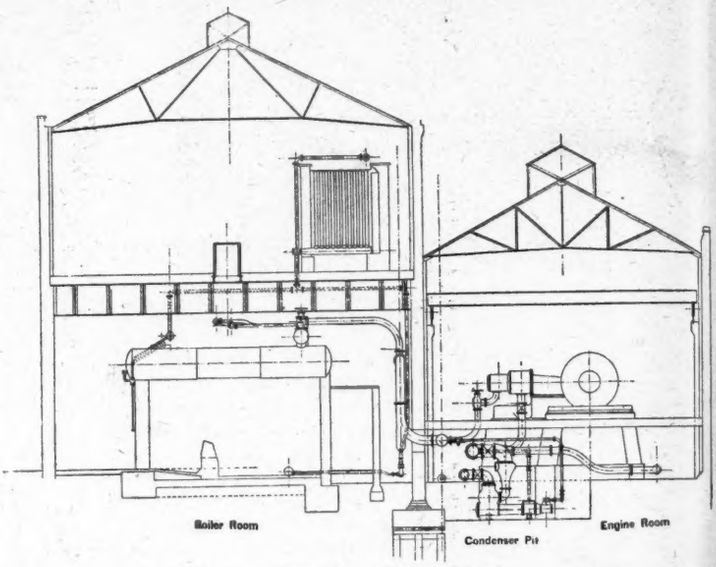
Hackney.—The Vestry, finding that the tenders for buildings for the electricity works much exceeded their anticipations, modified their plans, bringing the lowest tender—that of Mr. J. Greenwood—down from £44,283 to £31,589. The tender was accepted as amended.

Hull.—The City Council has accepted the tender of Messrs. Thos. Parker & Co. for transformers for the Hessle Road sub-station at £5,895.

Walthamstow.—The following tenders were sent in for 45 arc lamps, to Mr. J. Enright's specification:—

Messrs. Andrews	£2,064 19 0
The Brush Company	1,860 0 0
Messrs. Callender & Co.	1,796 0 0
The Brockie Pell Arc Company	1,755 2 6
The Transmission Company	1,658 0 0
The General Electric	1,627 15 0
Messrs. Johnson & Phillips	1,524 9 6
*Messrs. Oliver & Co.	1,373 17 6
The Gilbert Arc Lamp Company	1,277 10 0
Messrs. Frank Suter & Co.	1,273 10

* The contract was awarded to Messrs. Oliver.



Norwich: Section of Power Station.

Ealing.—The following tenders have been received by the District Council; Mr. J. Douglas Knight is the electrical engineer:

Steam Alternator.

Messrs Crompton & Co., Limited, with Belliss compound condensing engine	£2,784 15 0
Messrs. Siemens Bros. & Co., Limited, with Belliss compound condensing engine	2,581 11 0*
Messrs. Siemens Bros. & Co., Limited, with Browett-Lindley compound condensing engine	2,945 0 0
Messrs. Crompton & Co., Limited, with Belliss triple-expansion engine	3,054 15 0
Messrs. Siemens Bros. & Co., Limited, with Belliss triple-expansion engine	3,151 11 0

Storage Batteries.

The Electrical Power Storage Company	£1,671 5 0
Maintenance for 10 years per annum	153 0 0
The Hart Accumulator Company	1,979 14 0
Maintenance for 10 years per annum	196 0 0
The Marquand Accumulator Company	2,360 8 6
Maintenance for 10 years per annum	132 0 0
The D. P. Accumulator Company	1,522 11 6
No figures for maintenance were sent in by the D. P. Company, but a letter was read stating that the cost of renewals represented a percentage of 4½ during six years.	
The Chloride Electrical Storage Syndicate, Limited	2,576 0 0
Maintenance for first five years per annum	142 0 0
Maintenance for second five years per annum	166 0 0
The Tudor Accumulator Company	1,836 3 0*
Maintenance for 10 years per annum	18 0 0

* These tenders have been recommended to the Council for acceptance, subject to the sanction being obtained from the Local Government Board for the necessary loan.

London.—The London County Council on Tuesday considered the undernoted tenders for the supply of about 65 lamp standards in connection with the electric lighting of Victoria Embankment and Westminster Bridge:

	Price per standard.
A. Brown & Sons, Londonderry	£27 0 0
Mackenzie Bros., Edinburgh	28 5 0
J. Allen & Son, Glasgow	29 10 0
W. Macfarlane & Co., Glasgow	29 10 0
" " (alternative design)	31 0 0
" " " (accepted)	30 0 0
R. Carr & Co., London	30 0 0
W. A. Baker & Co., Newport, Mon.	32 10 0
" " (alternative design)	15 0 0
W. Lucy & Co., Oxford	34 10 0
W. Singer & Co., Frome	35 0 0
T. Brown & Co., Birmingham	39 10 0

The committee recommended, and the Council decided to accept, the tender of Messrs. Macfarlane & Co. at £30 per lamp standard.

The following tenders were received for the wiring of the new fire station at Paddington:—

Tamplin & Makovski (accepted)	£248 4 6
Barlow Bros. & Co.	267 0 0
Concentric and General Contract Company	264 0 0
F. A. Glover & Co.	280 0 0
F. J. Coleby	282 0 0
G. E. Taylor & Co.	304 0 0

The following firms tendered for the supply of a 2-ton overhead traveller for the generating station now being built on the Victoria Embankment :—

Broom & Wade, High Wycombe	£170 0 0
J. Whitley & Co., Bramley, Leeds (accepted)	214 2 0
H. & G. Measures, Croydon	435 0 0

FORTHCOMING EVENT.

Saturday, August 4th.—2 p.m. The annual general meeting of North of England Institute of Mining and Mechanical Engineers will be held in the Wood Memorial Hall, Newcastle-on-Tyne.

NOTES.

Reversibility of Voltaic Cells.—Under the decidedly misleading title of "Reversibility of Voltaic Cells," Mr. P. S. Moore has communicated to the Physical Society the results of some interesting and instructive experiments which he has made as to the effect on the electromotive force and internal resistance of certain cells, of sending an opposing current through them. Five cells were tried formed as follows :—Copper-zinc in sulphates, copper-cadmium in sulphates, copper-zinc in chlorides, and copper-cadmium in chlorides, and also the Clark cell. For the experiments a Crompton potentiometer was used. Each cell consisted of two glass vessels (short boiling-tubes) which had side-tubes blown in them. These side-tubes were connected by a short piece of india-rubber tube, to which was attached a screw-clip. It was found that, unless wads of cotton-wool were placed in the connecting tubes, it was necessary to have solutions whose densities only differed in the fourth place. With the wads there was practically no diffusion, and the internal resistance was not unduly high. The solutions were made up approximately to the formula R. 100 H_2O, where R is the molecular formula of any salt. The densities were then adjusted until they were approximately equal. The description of the experiments is somewhat confused and unsatisfactory, and the densities of the currents are not worked out and given. Mr. Moore sums up the results of his experiments as follows :—"During the experiments, so long as diffusion was prevented, the E.M.F. of the cells remained constant. Even under the most unfavourable circumstances, viz., when the reverse current through 4,000 ohms was running through the cell, the E.M.F. only altered about two millivolts. The conclusion to be drawn from the results is that the cells treated, and consequently all similarly constituted cells, are reversible; for the differences in the values of the E.M.Fs. when calculated and when observed are not greater than might be expected as errors of experiment. A few experiments were also carried out with the Clark cell. In the first experiments the Clark standard consisted of two Clark cells in parallel. These were now separated, and one used as a standard and the other as the experimental cell. The internal resistance of this cell is, of course, comparatively small, so that it was necessary to use smaller resistances than were used in the previous cases. These resistances were therefore made equal to 3,000, 2,000 and 1,000 ohms respectively. With the resistance = 1,000 ohms, it was found that the current was much too large, as the E.M.F. of the cell decreased very rapidly when running the current. But the reverse current gave a fairly good result, as might be expected. For the direct current would cause the solution of Hg_2SO_4 to become weaker, and the solid present would not immediately saturate the solution. But the reverse current would cause Hg_2SO_4 to be formed in the solution, which would therefore deposit some solid, but would at the same time remain saturated. Thus, all the results from the reverse experiments are better than the corresponding direct results; but considering the nature of the cell, these latter are fairly good. Thus we may say that the Clark cell, besides the others treated here, and those similar to them, is reversible."

Electric Traction and Metropolitan Railway.—Addressing the shareholders of the Metropolitan Railway on Friday at the half-yearly meeting, the chairman, Mr. John Bell, said :—

There is one subject in the report which I am sure will interest you as much as it does the board, and that is the question of working the Inner Circle electrically. The paragraph in the report is as follows :—The arrangements—referred to in previous reports—for an experimental working by electricity between Earl's Court and High Street, Kensington, stations, have been completed, and an electrical train has been working daily since May 31st last. In view of the importance to the Metropolitan and District Railway Companies of adopting electricity as a motive power, a committee consisting of three members from each of the boards of the companies has been appointed to consider the question of applying electric traction to the working of the Inner Circle, and it has been agreed between the companies to invite eminent electrical traction firms to submit plans and specifications, with detailed estimates and tenders for the necessary installation. That explains exactly the present position of the matter. As regards the experimental train, it is stated by the experts to be working satisfactorily, and as you will see, other and important steps have been taken consequent upon their reports, and the results of the experiments we made ourselves at Wembley Park. It may possibly seem that we have spent too long a time upon these experiments, but the difficulties which have had to be surmounted were greater than many people suppose. It is not a *new* railway we have to deal with, but a railway constructed for steam traction, and carrying at the present time something like 100,000,000 passengers per annum. This enormous traffic must be worked—and worked without a hitch so far as human means can provide—whilst the change from steam traction to electric traction is in course of being made. It is a very different thing, as you may imagine, from the opening of a new electric railway constructed for electric traction, and upon which a traffic has to grow. But that is not all. We have to deal with foreign traffic, that is, traffic of other railway companies which is brought on to and worked over a portion of the Inner Circle lines. These are the difficulties, or at all events the main ones, and I want you to bear them in mind. Then comes the question of surmounting them, and I am sanguine enough to think—and my colleagues agree with me—that they are capable of being overcome. As regards the physical difficulties, we are convinced that the science of electrical traction has now so far advanced, and is so much better understood than it was even a few years back, that, notwithstanding the enormous traffic to be accommodated, the new means of traction is practicable for working the Circle, and we are determined to do all in our power to make the change as quickly as possible. The best and most practical knowledge of the science is, as we believe, centred in the leading electrical traction firms, and what we propose therefore to do—and we are acting in this matter in concert with the District Company—is to ask some of the most eminent firms to submit to us their view as to the best method or system to adopt for the working of the Circle, and to invite them to submit offers with plans and specifications for the installation. We are sending to the various firms a memorandum of preliminary particulars to guide them in preparing their specifications, and we shall, of course, give them any information they may require to enable them to submit offers. Any firms desirous of tendering and not receiving the specification will be supplied on application to the office.

Liverpool Engineering Society.—On Friday afternoon last, about 90 members of the Liverpool Engineering Society proceeded by special invitation to the works of Messrs. C. & A. Musker, Limited, at The Brook, Liverpool, and made an inspection of the extensive premises. The Messrs. Musker built up an extensive business as makers of lifts and electrical appliances, at Dundas Street, Bootle, but the capacity of the Bootle works, though large, was completely outgrown. A site containing about 18,000 square yards was therefore acquired at The Brook, and the present large pile of modern works was erected. The business was transferred to them about six months ago. The works are lighted throughout by electricity, and electrical driving power is used. A branch of manufacture which Messrs. Musker have taken up is that of steam motor wagons, their type of wagon being driven by a four-cylinder single-acting engine, which is completely cased in, and works in an oil bath. A coil boiler of the "flash" class is used for generating steam. These wagons, the lifts, and the electrical power machinery, were inspected with much interest.

London's New Electric Railway.—84,500 passengers were carried by the Central London Railway on Monday, the opening day. This, at 2d. per head, represents the respectable sum of £700 odd. On the second day 90,000 people travelled.

Brine and Electricity.—Some idea of the scope which there is for chemical manufacturing companies in England working electrical processes, may be formed from the figures submitted to the Northwich Salt Compensation for Subsidence Board at a meeting held on Friday last. The returns from the brine pumpers showed that during the year 537,000,000 gallons of brine liable to tax under the compensation scheme had been raised in Cheshire. Much of this brine was decomposed by three methods now used on a large scale for the manufacture of soda. The newest and the extending method is that of electrolysis. The growth and prosperity of the Castner-Kellner Alkali Company, Limited, the company now working the electrolytic method, has been remarkable. In four years this company doubled its electrical generating plant, which meant its productive capacity, and has paid 8 per cent. steadily. The prospectus of the American Castner Electrolytic Alkali Company was issued a fortnight ago. This company has works of 2,000 H.P. at Niagara Falls, and it is intended to increase this capacity to 6,000 H.P. The works of the Electrolytic Alkali Company are being pushed forward at Cledford Bridge, Cheshire, where the new Hargreaves-Bird process will shortly be carried on. A third process—the Rhodin—will probably be brought into operation on a large scale at no distant date. All of these companies will carry on the manufacture of alkali and bleaching powder by means of electricity, the sodium chloride in solution as brine being decomposed by the electric current, so as to yield soda and chlorine. In view of the extent of the world's consumption of soda and bleaching powder, the electrical manufacture of these products may be said to have hardly begun. The figures quoted above of the total pumping of brine for the year represent practically an inexhaustible supply. This is the raw material of the electrical alkali companies. A large extension of this branch of electrical industry may therefore be counted upon, and as generating machinery of high capacity will be used, it promises to be a useful branch to electrical engineers.

Mono-Railways.—Before the members of the Association of Municipal and County Engineers at the Westminster Town Hall, on the 20th ult., Sir W. H. Preece gave an address on the proposed electric railway between Manchester and Liverpool, which was rejected by a committee of the House of Commons this Session. Sir William explained the details of the scheme, and said that there would be no risk in a speed of 110 miles per hour; any one could travel in absolute comfort at a speed of 200 miles an hour, and the only danger would be that of a sudden stoppage. There were two reasons why electric traction was superior to steam traction, the first being that they could apply at once to the driving wheel the whole power at their disposal; and the second being that the application of power was continuous, whereas in a steam locomotive the application of power was variable. There were of course dangers in all railways, but in this railway they would be reduced to a *minimum*. When the Bill was before the Parliamentary Committee the question of braking the speed exercised the minds of the Committee, and unfortunately at that time they had not sufficient knowledge to answer the questions put. They had since found out that with the Westinghouse air brake the train could be stopped within 900 yards; but in addition to that they had on the coaches two motors, each of which could be reversed, and would act as an electric brake, and would without doubt stop a train going at 110 miles an hour at 500 yards. A discussion followed. Seeing that the maximum braking power is obtained when the wheels are just short of skidding, and that the friction brake can easily be made to skid the wheels, we fail to see how any additional braking is to be obtained with the motors unless they are used in connection with magnetic slipper brakes on the rails.

Institution of Electrical Engineers' Meeting in Paris.—It is announced that permission has been kindly granted for the Institution of Electrical Engineers to hold a reception in the British Royal Pavilion in the Paris Exhibition from 5 to 7 p.m. on Wednesday, August 22nd, and that arrangements for the reception are being made accordingly.

Liverpool Overhead Railway.—A remark in the report of the Liverpool Overhead Railway Company points to the large demand there has been for material for electrical tramways during the last few months. The report states that there has been considerable delay in completing the Waterloo and Crosby tramways, owing to the difficulty experienced by the local authorities in obtaining material. No one who knows how largely constructive work of the kind has gone on in the district of Liverpool during the last 12 months, will be surprised to hear that there has been difficulty in obtaining material. The wonder is, rather, that so much material has been delivered and so much work been completed. The company, it may be mentioned, has now a serious competitor in the electric tramways, which are worked by the Corporation, and which run north and south, as the Overhead Railway does, with long-distance fares of 1d. against the company's end-to-end or short-distance fare of 2d. This competition has caused the directors of the railway company much concern, and will have to be met in some special way at a very early date.

The Hughes Bequest.—Under the terms of the will of the late Prof. D. E. Hughes, F.R.S., the eminent electrician, the sum of £4,000 was bequeathed to the Royal Society, as well as similar amounts to the Institution of Electrical Engineers and the Paris Academy of Sciences. The Royal Society has decided to devote its legacy to instituting a gold medal, to bear the bust of the donor, and to be awarded annually for original work in the department of electricity and magnetism or the applications of those sciences, provided that, if an interval of one year follows before an award is made, any balance of funds will accrue to the medallist. No restriction of sex or of nationality is to be allowed to weigh in the selection of suitable recipients for the medal.

Marriage.—The wedding took place at St. Saviour's Parish Church, Jersey, on July 25th, of Mr. E. J. Hidden, district manager in Liverpool of the National Telephone Company, Limited, and Miss Isabel May Laurens, only daughter of the late Mr. James Laurens, "Commis-Denunciator," Jersey, where a family reception was held at the residence of the bride's mother; and the happy couple subsequently left for St. Malo, *en route* to London and Chester, to spend the honeymoon. Mr. and Mrs. Hidden were the recipients of numerous handsome presents, several to the former being from the staff of the National Telephone Company.

Off for the Holidays.—We have received two of the Great Eastern Railway Company's "Annotated Time Tables," one for the Aldeburgh Express, the other for the Hunstanton Express. The idea of writing a bright and chatty description of the places through which the trains pass, with a marginal table announcing the precise time the train is due at any given station along the route, is a capital one, especially as these little booklets are quite of educational and historic value. The 15 pages to which they extend are charmingly illustrated, and the G.E.R. Company, always to the fore in enterprise, is to be congratulated on producing such artistic aids to the travelling public or holiday makers in East Anglia.

Central Technical College.—At a meeting of the Council of the City and Guilds of London Institute, held on Monday, the diploma of "Associate of the City and Guilds of London Institute" was conferred on the following matriculated students who have this year successfully completed a full course of instruction in electrical engineering at the Central Technical College:—T. L. James (Siemens Medal and premium), V. M. Allen, F. C. N. Bergh, J. H. Brown, H. Burge, H. H. Crockford, B.A., W. A. Del Mar, E. Fawssett, P. Good, S. Gowan, H. J. Humphreys, A. P. Hutchinson, H. L. E. Kennard, W. J. Line, F. G. Maunde-Thompson, G. H. Montgomerie, J. A. Parker, H. J. Thompson, M. A. Wood.

Institution of Junior Engineers.—On Friday, July 27th, a large number of the members availed themselves of the opportunity afforded by Mr. Basil Mott, for visiting the generating station of the Central London Railway, at Shepherd's Bush, under the guidance of Mr. B. Pontifex. At the conclusion of the visit, a special train was provided to convey the party from Shepherd's Bush to the Bank and and back, and the system of working the trains was thereby illustrated. For the arrangements which had been made to render the visit of such interest, the thanks of the Institution were expressed by Mr. A. W. Marshall, before the members dispersed.

Appointments Vacant.—A senior demonstrator in applied physics is wanted at the South-Western Polytechnic, Manresa Road, Chelsea, and a senior demonstrator in electrical engineering; salary £150 per annum.

Telegraph linemen are required for Lagos. Salary £200 per annum. See "Official Notices."

Brockie-Pell Arc Lamp Company v. Johnson.—The following came to hand too late for inclusion with the report on p. 170:—

In the Court of Appeal on Wednesday, before the Master of the Rolls, Lord Justices Rigby and Collins, the case of the Brockie-Pell Arc Lamp Company *v.* Johnson, was down for hearing on appeal of the defendants from a judgment of Mr. Justice Kekewich.

Before the case was called on, Mr. A. Walter stated that he and his learned friend, Mr. Graham, had settled all disputes between the parties, and by consent there would be an order on the terms which had been agreed upon.

The Master of the Rolls: Very well.

The Edison Incandescent Lamp.—The Edison lamp factory of the General Electric Company of America, turns out 55,000 lamps per day, or nearly 16,000,000 lamps per annum. Twenty years ago Mr. Edison, after two years of experimental work, gave the first public exhibition of his incandescent lamp in his laboratory at Menlo Park, and early in 1880 started the first Edison lamp factory.

The National Lecture Society.—With a view of increasing British trade and spreading a better knowledge of articles manufactured in this country, the National Lecture Society are arranging a series of illustrated addresses on British industries to be given in all important commercial centres throughout the world. Those who are desirous of availing themselves of this movement are invited to write to the honorary secretary, National Lecture Society, Imperial Institute, London, S.W.

NEW COMPANIES REGISTERED.

Broom & Wade, Limited.—This company was registered on July 12th, with a capital of £20,000 in £5 shares (3,000 ordinary and 1,000 deferred), to acquire the business carried on by Broom & Wade, at High Wycombe, Bucks, to adopt an agreement with H. S. Broom and J. T. Wade, and to carry on the business of mechanical and electrical engineers, contractors, boiler makers, iron and metal founders, launch and shipbuilders, iron and steel converters, smiths, &c. The first subscribers (each with one ordinary share) are:—H. S. Broom, High Wycombe, Bucks, engineer; J. T. Wade, High Wycombe, Bucks, engineer; J. C. Peache, Layer Marney, Essex, gentleman; E. Charrington, 63, Queen Victoria Street, E.C., gentleman; G. Maineuse, 19, Lincoln's Inn Fields, W.C., solicitor; H. Vaughan, Woodburn, Bucks, secretary; and H. G. Brown, Halesworth, Suffolk, auctioneer. The number of directors is not to be less than two nor more than four; the first are J. C. Peache, H. S. Brown, and J. T. Wade; qualification, £250. Registered office, High Wycombe, Bucks.

Grosvenor Engineering Works, Limited (66,708).—This company was registered on July 20th, with a capital of £2,000 in £1 shares, to acquire the business carried on by C. E. Lawford, at 112, Grosvenor Road, Pimlico, and to carry on the business of mechanical engineers, model makers, ironfounders, electrical engineers, wharfingers, &c. The first subscribers (each with one share) are:—Mrs. H. Posen, 53, Portland Place, W.; C. E. Peczenik, 53, Portland Place, W., engineer; S. C. Coles, Grosvenor Mansions, S.W., consulting engineer; E. T. R. Wilde, 61, Fore Street, E.C., chartered accountant; P. A. L. Pryor, 27, Gilston Road, S.W., consulting engineer; R. Blagden, Outer Temple, 222, Strand, W.C., solicitor; and E. S. Smith, 16, Linden Avenue, Kensal Rise, W., clerk. The number of directors is not to be less than two nor more than six; the first are S. C. Coles, P. A. L. Pryor (managing director), and C. E. Peczenik (secretary); remuneration of managing director and secretary, £150 each per annum; others £50 each per annum.

Harwich Electric Lighting and Tramways Company, Limited (66,783).—This company was registered on July 27th, with a capital of £50,000 in £1 shares, to acquire certain powers under the Harwich (Corporation) Electric Lighting Provisional Order, 1892, confirmed by the Electric Lighting Provisional Orders (No. 2) Act, 1892, and to carry on the business of electricians, mechanical and electrical engineers, tramway and light railway proprietors, contractors, &c. The first subscribers (each with one share) are:—G. E. Heyl-Dia, Birk Crag, Great Clowes Street, Broughton, Manchester, electrical engineer; G. Leve, 82, Victoria Street, S.W., manager; W. W. Norman, Essendene, Chobham Road, Woking, secretary; W. J. Forsham, 42, Sankey Street, Warrington, solicitor; A. W. Howard, 94, Bewsey Road, Warrington, accountant; T. Burton, The Hollies, Liverpool Road, Warrington, manager; and J. Mason, Beechwood, Fearnhead, near Warrington, miller. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first; qualification, 50 shares; remuneration as fixed by the company. Registered office, 42, Church Street, Harwich.

C. V. Lamp Syndicate, Limited (66,764).—This company was registered on July 26th, with a capital of £14,000 in £1 shares, to manufacture and deal in electric and other lamps, accessories and appliances, and to carry on the business of electricians, electrical, hydraulic, gas and general engineers, suppliers of electricity, &c. The first subscribers (each with one share) are:—R. G. Cheshire, 14, St. Helen's Place, E.C., clerk; W. A. Hill, 1, Colwell Road, S.E., clerk; C. R. Pearson, 2, Oakfield Road, Ilford, clerk; W. J. Hill, 124, Underhill Road, S.E., stenographer; A. G. Coggan, 38, Kempe Road, West Kilburn, N.W., clerk; W. Waters, 2, Stonard Road, Palmer's Green, N.; and A. Bullard, 34, Studholme Street, Peckham, accountant. The number of directors is not to be more than five. The subscribers are to appoint the first; qualification, £100; remuneration, £150 per annum, divisible.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cuba Submarine Telegraph Company, Limited (4,710 C).—This company's annual return was filed on May 31st, when the entire capital of £220,000 in £10 shares (6,000 preference) had been taken up and paid in full.

CITY NOTES.

Crompton & Co., Limited.

The twelfth annual general meeting of the shareholders of this company was held on Monday at the Cannon Street Hotel, Mr. John Trotter presiding.

The Chairman, in moving the adoption of the report, said it was of a very satisfactory character, and the board had great pleasure in meeting the shareholders to celebrate the return of the company to a period of prosperity, which he hoped might last for a considerable time. The accounts were considerably altered from those which were placed before them last year. The trading expenses amounted to £20,245, against £17,382 last year, which was a considerable increase. Administration and head office expenses stood at £10,395, against £8,111, which again was an increase. The repairs to buildings stood at practically the same figure—£675, against £625. Depreciation was very much the same—£4,248, against £4,159. The net profit amounted to £31,326, against £23,000 last year. In considering the increase in the trading and the administration expenses, they must take into consideration the gross profit, which stood at £66,891, against £53,252 last year. In other words, they had done a very much larger business, and made a bigger profit on it, because, if they took all the expenses, they amounted to £35,564, which was equal to 54¾ per cent. on the gross profits. In the corresponding period last year the percentage was 56¾ per cent., so they had succeeded in getting the ratio of gross profits down another two points. It was interesting to know how that percentage had stood in each of the four years since the business was taken in hand by the present board. In 1896 the ratio of expenses to gross profits was 77½ per cent.; the following year it was reduced to 72½ per cent.; in 1898 it fell to 67 per cent.; 1899 it was 56¾ per cent.; and this year they had got it down to 54¾ per cent. He would like to see it down to 50 per cent., but he did not know whether they would be able to do that, because during the period of

working up the business to its present position they had been keeping everything down to perhaps almost a dangerous limit. The time had come when they had entered upon a period of greater prosperity, and they felt that, in justice to their staff, who had stood by them in the most splendid manner in the years of trial, they ought to do something to improve their position. There were many other expenses in connection with the business which they had screwed down to almost the lowest possible limit in order to bring the business round, and they must be a little more liberal now that they could better afford it. Therefore he did not think they must expect a very much greater reduction in the ratio of the expenses of the business to the gross profit. The balance of net profit was £24,636, as against £15,489 in the previous year; and they proposed to pay a dividend at the rate of 9 per cent. per annum for the half-year, making 7½ per cent. for the year. The new shares issued last year were offered in the first instance to the shareholders at a premium of 5s. per share, and a very large amount was taken up. The balance was issued to shareholders and others at a premium of 10s. The premiums so received had been placed to the reserve fund. That fund at the end of last year stood at £13,046, and they proposed to add another £12,000, which would bring it to £25,000. They proposed to write £5,000 off the goodwill; £5,000 from the patents account; to set aside £5,000 in case of any depreciation in the investments, and to write off the whole amount standing as the value of the electric cooking and heating apparatus, which would leave about £7,000 still to the credit of the reserve fund. In conclusion, the chairman said that the Chelmsford Electric Lighting Company had responded very well to the extra amount of work which had been put into it, and during the first six months of this year there had been an increase of over 33 per cent. in the amount of lamps lit and in the receipts.

Mr. Carleton F. Tufnell seconded the resolution, and the report was adopted.

National Telephone Company.

The twenty-sixth ordinary general meeting of the shareholders of this company was held on Thursday of last week at the Cannon Street Hotel, Mr. J. S. Forbes presiding.

The Chairman, in proposing the adoption of the report, said the main features of the half-year were that the revenue had increased, and so had the expenditure, the latter in a larger proportion than the former, due to one of those casualties incident to their business, a big snowstorm. That involved an extraordinary expenditure of some £25,000, and the board had thought it wise to put the whole of that amount to the revenue of the half-year. The increase in the income had amounted to £97,500, and the working expenses had increased by £77,000. The net result was an increase of £11,000 in the revenue, which would have been £36,000, had it not been for the exceptional expenses incurred, owing to the snowstorm to which he had already referred. They proposed to pay the dividends as usual on the first and second preference shares, and 5 per cent. per annum on the third preference, and 6 per cent. per annum on the ordinary shares, which would leave a balance of £55,000 to be carried forward, or £6,000 less than in the corresponding period. The Post Office royalties for the six months amounted to the enormous sum of £68,257, an increase of £9,472. Considerable correspondence had been received from shareholders on the decision come to by the board, to pay the ordinary dividend, less income-tax, but that step had been taken in fairness to other shareholders. Regarding the future, he wished to say that they had had numerous correspondence with the postal authorities. They, on their part, had been as reasonable and as anxious as men could be to work in harmony and loyally with the Post Office as regarded competition. They hoped that the competition would be conducted rationally and fairly, and on that point they had full confidence in those pledges upon which men of honour relied, when given on authority by responsible politicians or authorities. Mr. Hanbury, who was chairman of the Parliamentary Committee which determined that there should be competition, knew perfectly well how to protect the interests of the State, and at the same time he had showed every disposition to act on the square with the company, and his public utterances on that point must be taken to be his intentions. They wanted fair treatment as between competitors whoever and wherever they might be, and they did not believe that any act of the Government would lead to anything like a want of recognition of what the company had done, and what they might have done if they had not been hampered, and what they were still willing to do in co-operation with the Government to make the telephone still more efficient. They would, however, strongly resent anything in the way of confiscation.

Lord Harris seconded the motion, and the report was adopted.

Edison & Swan United Electric Light Company.

The seventeenth annual meeting of the shareholders of this company was held on Tuesday at the Cannon Street Hotel, Mr. J. S. Forbes in the chair.

The Chairman, in moving the adoption of the report, explained that, with the concurrence of the auditors, the board had thought it necessary to make an alteration in the stock-taking. The number of articles comprised in their stock included from 75,000 to 100,000 varieties, as the business was made up of a very large number of small items. They had come to the conclusion that they should close the year at June for the purposes of stock-taking, which would really put them in something like absolute knowledge as to the nature of the stock, and that had turned out to be rather a longer job than they had anticipated. It had involved estimating for the last month of June as to the amount of the profits, and therefore that month's profits had been brought into the accounts subject to their turning out to be a little more or less one way or the other. The stock was put down in the profit and loss account at the value of £201,648. They had already paid something in the nature of a provisional dividend for the first half-year, and they now proposed to pay at the same rate for the second half, which would make a total dividend for the year of 6 per cent., and leave £6,199 to be carried forward. Since the accounts were made up it had been ascertained that the stock was worth at least £6,000 more than what they had valued it at, and therefore the balance might have been £12,000 instead of £6,000. They had largely increased the growth of the volume of the company's business during the year. For the corresponding period it was £241,400, while this year it had increased by £44,000. The stock on May 31st this year amounted to £201,648, against £160,000 last year, showing an increase of £41,487. The item for depreciation of plant amounted to £13,936. They were writing down from the profits from year to year, and in one way or another building up a reserve. The balance brought into the year was £10,599. The business had increased from £241,000 to £285,000; the stock from £160,000 to £201,000, and the interest receivable from investments and other sources had increased by about £1,100. The balance on the profit and loss account stood at £43,388 as against £44,792 last year, but if they added the £6,000 on to the value of the stock which they really ought to do, the balance was really £49,388. They had had to raise some additional capital in the course of the year which had increased the amount payable for interest by £1,994.

Mr. J. W. Swan, F.R.S., seconded the motion, and the report was adopted.

The City and South London Railway.

The thirty-second ordinary general meeting of the proprietors of this company was held on Tuesday, at Winchester House, under the presidency of Mr. C. G. Mott, the chairman.

In proposing the adoption of the report, the Chairman said he was sorry to say that the board had again to meet the shareholders with a reduced dividend. It was, however, entirely due to exceptional circumstances, which he hoped and believed would not occur again, and he hoped that when he had the pleasure of meeting the shareholders next year he would be able to put before them an increased dividend. Great efforts had been made to get the extensions opened for traffic, and by dint of hard work the extension to Moorgate Street was opened about March 1st and that to Clapham Common by June 1st. The regrettable breakdown on one of the lifts at London Bridge station, to which their attention had doubtless been directed, was due to a combination of circumstances which he did not think was ever likely to occur again. To prevent any such occurrence in the future the directors had taken exceptional precautions—precautions which they were advised by their engineers were not absolutely necessary, but their desire was that when the public entered any of their lifts they should be able to feel that they were in a perfectly safe place. The other lines with which they were to be connected, and which they hoped would bring them in a good deal of additional traffic, were not opened as early as they had anticipated they would be, but their most important connection, viz., the Central London Railway, which ran from the City to Shepherd's Bush, was opened to the public for traffic on Monday. The subway from their railway which connected it with the Central London was now being used, and he believed that as soon as the public had fully grasped the convenience of the system they would get a very large accession of traffic through that connection. The subway between their station at London Bridge to that of the London, Brighton & South Coast line was being proceeded with, and they hoped to be in a position to open it in the course of another six months; and when it was open he believed it would give them additional traffic. He was glad to say that the extension to Islington was proceeding very fast. The greater part of the tunnels were completed, and only the underground stations remained to be finished—one of which was already completed—and the surface stations and the lifts. They were in hopes that the extension would be complete by next March. One reason for the shrinkage in the dividend was that during the period under review they had thrown out of use three-quarters of a mile of the line between the Borough and their old King William Street station. They regarded that three-quarters of a mile as a very valuable asset. They made an agreement with the City and Brixton Company for an extension of the line to Brixton, which was to be worked by them, and they were to receive the whole results of the working of that three-quarters of a mile, but unfortunately the Brixton Company had not been able to raise the necessary capital. They had approached the Brixton Company with a view to seeing whether the agreement might not be slightly modified, but negotiations were still proceeding. The report was adopted, and subsequently a resolution was passed modifying the agreement with the City and Brixton Company.

Rand Central Electric Works.

The annual meeting of the shareholders of this company was held on Tuesday at Winchester House, Sir C. Rivers Wilson in the chair.

The Chairman said that it was impossible to hold the meeting at an earlier date because of the war, which had rendered communication with Johannesburg exceedingly difficult, and at times altogether impossible. The total revenue for the year amounted to £50,674, and the working cost to £49,834. There was thus a profit of £839

18s. 1d. against a loss of £5,742 7s. 6d. in 1898. Out of this year's profits they proposed to carry £83 19s. 9d. to the reserve fund. The receipts for power supplied amounted to £49,640 against £42,723 in 1898, but under normal circumstances, and calculated on the possible output of power contracted, the receipts might have been from £10,000 to £15,000 in excess of what they were. They would remember under the equipment contract Messrs. Siemens & Halske guaranteed that the profits should be sufficiently large to provide dividends of 6 per cent., 8 per cent., and 10 per cent. per annum respectively for the years 1897, 1898 and 1899. The necessary amounts to provide the guaranteed dividends for the first two years had been duly paid, but in regard to the profits of last year the contractors claimed a partial release on account of the hostilities in South Africa constituting a case of *force majeure*. The directors had given that question every consideration, and they proposed to relieve the contractors to the sum of £7,371 13s. 7d., which was the estimated net loss occurring during October, November and December, 1899. That would reduce Messrs. Siemens and Halske's liability to £21,872, and would admit of the payment of a dividend of 7½ per cent. so soon as the money was received from the contractors. The shareholders would be glad to know that no harm had been done to the company's works during the war, and they had been maintained in a very efficient state. He concluded by proposing a resolution adopting the report and confirming the arrangement with Messrs. Siemens & Halske already referred to.

Mr. Alfred H. Marker seconded the motion.

Mr. S. Cohn addressed the meeting at considerable length in opposition to the making of any allowance to the contractors, but eventually the motion was adopted with one dissentient.

Anglo-American Telegraph Company, Limited.

Mr. F. A. Bevan took the chair on Friday afternoon at Winchester House over the half-yearly meeting of the proprietors of the above company, and in moving the adoption of the report, said that the ordinary receipts for the half-year had been very similar to the corresponding period, there being a difference of only £983 in favour of the past half-year, and consequently they might congratulate themselves as far as the ordinary traffic was concerned. He would point out that so far from that company or any of the associated companies having a monopoly across the Atlantic there would be no fewer than 13 cables across the Atlantic when the new German Azores cable was opened. Competition was, therefore, becoming greater, and under the circumstances it was most satisfactory that they had been able to increase the ordinary traffic. There had, however, been a large falling off in the earnings of the repairing ship *Minia*. Last year they earned £19,000 by the aid of the *Minia*, but this year that sum was reduced by £17,975, and that alone accounted for the diminished sum they were able to carry forward. That was a matter over which the directors had no control, and on the other hand, there was something to be said with regard to the good order of the cables. There was a reduction of £57,000 shown in the balance-sheet in the amount owing to the company, and there was an increase of £22,454 in the item of cable in stock. The company had been laying a new cable between France and England from Cuckmere to Havre, the old cable between Salcombe and Brest having become much worn, and this was expected to prove advantageous to the company. The new German Azores cable would be opened on September 1st, and it would no doubt take a good deal of traffic, especially from Germany to America, and nothing that the directors might do could possibly prevent that. The cable was heavily subsidised by the German Government, and would no doubt be a very good one. Still he hoped that the company would be able to retain a very considerable amount of the traffic coming from America to Germany. There were only two collecting companies in America, viz., the Western Union and the other American company which was in partnership with the Commercial Cable Company, and he believed the Western Union would be able to collect a very large portion of the German traffic coming this way, and whatever the company collected would be either carried over their own lines, or handed to the Anglo-American Company. Negotiation had been going on between the directors and the authorities with respect to the moving of the Emden-Valencia cable, but no decision had yet been arrived at. If the cable were moved they hoped that the company would receive facilities from the German Government owing to the friendly action of the British Government, and that this would counteract, to some extent, what the directors regarded as a new feature. The British Government had been asked not to allow the cable to be moved, but there might be political reasons why they might think it wise to accede to the request of the German Government, but if they did that, they had good reason to believe that they would do all they could to help them in Germany in getting traffic. With regard to the "P. Q." lawsuit, the solicitor had requested him to ask the shareholders not to press him on that point to-day. Matters were going on, but it would not be wise to make a statement.

Sir G. FitzGerald seconded the motion, and it was carried.

Globe Telegraph and Trust Company.

The Marquis of Tweeddale (chairman) presided on Friday at Winchester House, E.C., over the twenty-seventh ordinary general meeting of the above company.

In moving the adoption of the report, the Chairman said he believed it would be regarded as highly satisfactory. They had not been able to recommend a large dividend, but their position had been well maintained, and they paid the same dividend as last year. The receipts, after the deduction of expenses, were £198,420, an increase of £530, while the expenses, amounting to only one-eighth of the capital, were somewhat less this year than last year. They were able to recommend a final dividend at the rate of 5¼ per cent. on the ordinary shares. He felt sure that the sale and redistribution of some of these securities would commend itself to the approval of the shareholders. The chairman then proceeded to deal at length with the various securities of the company, and pointed out that for the first time they held none of the preferred stock of the Anglo-American Telegraph Company, but had sold their remaining £70,000 at about the highest price that the stock had ever reached. They had invested the proceeds in the Brazilian Submarine Cable Company, or, rather, the Western Telegraph Company, as it was now known. They had increased their holding in the Commercial Cable Company by 100 shares, and at present held 400 shares. The Eastern Extension Telegraph Company had recently issued new share capital, which was offered to the shareholders *pro rata* to their holdings at £13 per share. They availed themselves of the offer and added 11,143 shares to their holding, and the cost of that purchase would be met by the sale of some other securities. They had sold 27 debentures in the London Platino Company at a substantial profit, and used the proceeds in the purchase of Commercial Cable shares. Ten of the company's certificates were drawn in the drawing of the Submarine Cables Trust, but the money had been re-invested in the company. They were aware that the market price of most submarine telegraph shares had fallen during the last year, due partly to the experiments in wireless telegraphy, and partly to the proposed Pacific cable, and, perhaps, also, to the general political outlook, which was not as reassuring as they would like it to be. Notwithstanding that the market price of their investments showed at the present day a very considerable surplus over the capital, which he believed amounted but a little short of £600,000. He had received a letter from a lady shareholder asking for some particulars with regard to the Marconi experiments, and what effect they were likely to have upon their company. He had only to say that the most competent judges were of opinion that the Marconi system would prove of great value in many respects, but was not likely to interfere injuriously with the transmission of messages by submarine telegraph. With regard to the Pacific cable, he understood that tenders had been invited for the laying of a British cable from Vancouver to Australia, and they would probably be sent in in the course of a few weeks. Beside that, two Bills were before the United States Congress to connect California with the Philippine Islands. One of these was designed to be under Government supervision, and the other by a private company. The rival schemes would probably be disposed of next December when Congress resumed its sittings. He need not assure them that the utmost attention to that matter would be given by the company affected, and the directors would do their best to protect the interests of their shareholders.

Sir James Pender seconded the motion, and it was carried without discussion.

The Aluminium Company, Limited.

Sir Henry Roscoe presided over the thirteenth ordinary general meeting of the above company held on Thursday at the Cannon Street Hotel, and in moving the report and accounts, explained that the reason why they were only for nine months was that they had entered into an agreement with the Cassel Gold Extracting Company, whereby an intercharge of the profits of that company and the profits of the Cassel Company had been arranged, and even if the amalgamation with the Castner-Kellner was not carried out, the accounts would be continued to be made up to March 31st. They had made profits for the nine months of £19,684, and after paying debenture interest and adding the sum brought forward, there was an available balance of £19,009. It was proposed to pay a dividend at the rate of 15 per cent., which would absorb £7,312, and carry forward £11,697. The working agreement with the Cassel Company was one which, in the interests of both companies, should not be made public, but it was one which the directors thought would be beneficial to the Aluminium Company. If the amalgamation with the Castner-Kellner was carried through, in addition to the dividend of 15 per cent., the shareholders would be participating in the profits of the Castner Company in respect of three of their shares for every one share the proprietors held in the Aluminium Company from March 31st. The directors recommended the amalgamation, as they were satisfied that sodium could be made very much cheaper at the works of the Castner Company than at their own works, and by the combination a stronger chemical company would be made, and the shares and debentures being of larger amount ought to be more marketable.

Mr. J. S. Parkin seconded the adoption of the report, which was carried.

At an extraordinary meeting which followed the necessary resolutions to carry out the amalgamation with the Castner-Kellner Company were carried.

Notting Hill Electric Lighting Company.

An extraordinary general meeting of the shareholders of this company was held on Wednesday at Winchester House, Old Broad Street, Sir W. Crookes presiding, for the purpose of considering resolutions to increase the capital.

The Chairman said they would remember that at the last meeting there was some discussion on the subject of increasing the capital, and it was then decided that there should be a meeting between the representatives of the holders of the different classes of shares and

the board to see if some arrangement could be come to, satisfactory to all parties. That meeting was held, and after considerable discussion in which many shareholders took part, it was unanimously agreed that the arrangements which were embodied in the resolutions he was about to propose, were the best for all parties. That meeting, therefore, was almost a formal one, simply to place before them the decisions which had been arrived at by the largest shareholders of all classes and the directors. He concluded by proposing the following resolutions:—"That the capital of the company be increased to £200,000 by the creation of 10,000 new shares of £10 each, such new shares to rank as ordinary shares. That 2,200 of the new shares be issued forthwith at a premium of £2 per share, 1,100 to be offered *pro rata* to the holders of the founders' shares, and the remaining 1,100 *pro rata* to the holders of the ordinary and ordinary preference shares. That the remainder of the new shares shall be issued at such times and at such price and under such conditions as the directors shall from time to time think fit, but so that the proportion thereof to be offered to the holders of the company's founders' shares shall be the same as the proportion now offered under the last preceding resolution."

Mr. Kitchen, in seconding the resolutions, said they were the outcome of a great deal of careful thought on the part of the directors and the shareholders. He thought that the arrangement was as fair a one as they could have arrived at for all parties concerned.

The resolutions were then agreed to unanimously.

Charing Cross and Strand Electricity Supply Corporation, Limited.—The directors have, after providing for debenture and other interest and dividend on preference shares, declared an interim dividend at the rate of 8½ per cent. per annum for the half-year ending June 30th, 1900, and carry forward £10,508. The interim dividend for the corresponding period of the year 1899 was at the rate of 8 per cent. per annum, with a carry forward of £8,300. The lamps connected during the past half-year have amounted to the equivalent of 24,242 8-c.p. lamps.

Bristol Tramways and Carriage Company, Limited.—The directors have declared an interim dividend to June 30th last at the rate of 7½ per cent. per annum, payable on August 4th, against 7 per cent. for the corresponding period. The total receipts of the company for the half-year were £74,991, against £72,396, an increase of £2,595 over the corresponding period, whilst the number of passengers carried was 12,061,613, against 11,408,683, an increase of 652,930.

W. T. Henley's Telegraph Works Company, Limited.—Interim dividends for the six months ending June 30th, 1900, will be paid September 1st, 1900, as follows:—On the ordinary shares at the rate of 8 per cent. per annum, less income-tax; on the preference shares at the rate of 4½ per cent. per annum, less income-tax.

Brompton and Kensington Electricity Supply Company.—The directors have declared an interim dividend at the rate of 7 per cent. per annum on the preference shares, and an interim dividend of 5 per cent. per annum on the ordinary shares for the half-year to June 30th, payable 8th inst.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending July 28th, 1900, were £1,350 12s.; receipts for corresponding period, 1899, £1,119 10s. 3d.; aggregate for half-year to date, £4,592 7s. 9d.; aggregate corresponding period of last half-year, £4,453 11s. 11d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending July 27th, 1900, were £3,544 12s. 11d.; corresponding period, 1899, £3,404 1s. 4d.; increase, £140 11s. 7d.

The City and South London Railway Company.—The receipts for the week ending July 29th, 1900, £1,610; July 30th, 1899, £958; increase, £652. Total receipts for half-year, 1900, to date, £5,905; corresponding period, 1899, £3,721; increase, £2,184. Miles open, 1900, 4½; 1899, 3½.

The Cork Electric Tramways and Lighting Company, Limited.—The receipts for the week ending Thursday, July 26th, 1900, were £526 14s. 9d.; corresponding week last year, £504 6s.; increase, £22 8s. 9d. Total to July 26th, 1900, £11,615 8s. 11d.; corresponding period last year, £10,398 17s. 5d.; increase, £1,216 11s. 6d.

The Dover Corporation Tramways.—The receipts for the week ending July 28th, 1900, were £270 10s. 8½d.; July 29th, 1899, £253 8s. 4d.; increase, £17 2s. 4½d. Total receipts to date, 1900, £5,564 8s. 8d.; corresponding period 1899, £5,212 15s. 8d.; increase, £350 13s. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 5,032; 1899, 4,855. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, July 27th, 1900, were as follows:—D. U. T. Co., horse cars, £34 2s. 3d.; ditto, electric cars, £4,001 7s. 11d.; D. S. D. Co., electric cars, £1,252 11s. 6d.; total, £5,288 1s. 8d; corresponding week last year—D. U. T. Co., horse cars, £2,127 19s. 8d.; ditto, electric cars, £1,867 19s. 5d.; D. S. D. Co., electric cars, £1,175 18s. 5d.; total, £4,671 17s. 6d.; increase, £616 4s. 2d.; aggregate to date, £19,587 13s 9d.; aggregate to date last year, £17,511 3s. 7d.; increase to date, £2,076 10s. 2d. The mileage worked is 43 miles electrically, 1 mile by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending July 30th, 1900, were £893; corresponding period, 1899, £628; increase, £265. Total receipts to date, 1900, £18,073; corresponding period, 1899, £9,894; increase, £8,179. Miles of track open, 1900, 14; 1899, 6½. Number of cars, 1900, 30; 1899, 15.

The Liverpool Overhead Railway Company.—The receipts for the week ending July 29th, 1900, were £1,671; corresponding week last year, £1,597; increase, £74. Total traffics from July 1st, 1900, £6,864; ditto corresponding period 1899, £6,330; increase, £535. Miles open 6·67 chains.

STOCKS AND SHARES.

Wednesday Evening.

The main interest and excitement of the week's dealing in stocks and shares electrical have centred round the railway market. The opening of the Central London on Monday last was sufficient cause for the advancing of the price of the undivided shares to nearly 10, whilst the halves were also better to 4⅞ for both. A quite uncommon amount of interest was displayed in the City on the occasion of London's new tube getting to work, and the first few days of its existence as a public artery will no doubt fully justify the anticipations of the company's prophets, as regards numbers carried and so on. Wishing the company every success, however, we must admit that a few years' trial will most likely be wanted before the line settles down into a thoroughly paying proposition. We doubt whether the system of charging uniform fares will conduce to prosperity, but that is, after all, a detail, and can be altered at any time that the directors consider a change advisable in the financial interests of the company. The report, just out, is considered very favourable in the market.

Metropolitan and District stocks both receded on the opening of the Central London, but Districts have since revived a little, and now stand at 28½. Metropolitan Consolidated stock is 99 to par, almost the lowest price touched this year. At the meeting of the company last Friday, Mr. John Bell referred at some length to the question of electric traction, and promised that the directors would do all in their power to make the change as quickly as possible. They were satisfied that by using electric power an economy would be the result as compared with the use of steam traction. The District Company is acting in concert with the Metropolitan, and the question of amalgamating the two Undergrounds is again on the *tapis*. Lord Claud Hamilton's remarks anent a new electric line under the auspices of the Great Eastern Railway have also aroused a lot of interest.

Brighter news from the front and from the Far East, have not been lost upon the markets, and the tone is hardening in most departments. The dastardly assassination of King Humbert gave a momentary shock to prices, but the rally was almost immediate. Nor had the sad death of the Queen's second son any effect upon the stock markets. We regret to notice that Mr. Adolf Goetz has succumbed to paralysis of the heart, in Switzerland. He was the prime mover in promoting the Rand Central Electric Company, whose object it is to supply electricity to the Witwatersrand mines.

For the month of July electric lighting companies appealed to the public for £417,000 new capital, bringing the total for the seven months up to a round 1½ millions sterling. The later issues have not, we fear, taken very well with the general public. Even for the County of London Debenture stock, which came out last week, the applications from outside were comparatively small, and the underwriters found themselves left with about 50 per cent. Some of them have sold their stock at a premium, however, and the price is nominally a shade over par. The Blackheath and Greenwich issue went rather better than was expected from such a poor prospectus, but we hear that underwriters of this did not get off very lightly.

Despite the fact that British Electric Traction oddments are now supposed to be all done with, there are still a few bargains being booked in them, and the whole shares are negotiable at about ⅜ premium. The Middlesex County Council is quietly working at its new light (electric) railway scheme.

Interim dividends are now coming thick and fast. The Charing Cross and Strand is better than that of last year with which it compares. Charing Cross new Preference, by the way, are quoted at ⅛ premium. Those who are wondering why the company wanted so much fresh capital have evidently forgotten the new Charing Cross and City enterprise. The Metropolitan Electric's dividend of 6s. per share is decidedly good, being 1 per cent. more than it was a year ago. 5 per cent. on Brompton and Kensington Ordinary goes against the same distribution in August, 1899.

Mr. J. Staats Forbes, as chairman of the Edison & Swan Electric, has been circularising the shareholders in that concern, and stating that a movement is on foot to bring the "B" shares into line with the "A," a step which would be detrimental to the latter if carried into effect. He accordingly appeals for the support of the "A" shareholders. In concluding his letter, he suggests that the price of the shares has been kept down to suit the purpose of certain Stock Exchange jobbers. As there are only four or five dealers who are the market in Edison & Swan shares, it would have been more to the point had Mr. Forbes particularised.

Keen competition is evidently ahead of the Anglo-American Telegraph Company, and the chairman states that the newcomer may open on September 1st. The stocks have maintained their prices very well, considering the situation, and with the fear ahead that the Deferred will come off very badly when the dividend is declared next February. Other telegraph descriptions are quiet. The seller of 500 National Telephone new shares, to whom we referred last week, succeeded in placing them the other day at 4 1/16 per share.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation July 25th.	Closing Quotation August 1st.	Business done during week ended August 1st, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	59 — 62	58 — 61 xd	...	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	112 —113	110½ 111½xd	112½	110½
3,062,240	Do. do. Deferred	Stock	...	18s. %	£1 7s.	11⅜— 12½	11⅜— 12½	12⅛	11⅛
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	...	2½— 3½	2½— 3½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	101 —103	102⅜	102¼
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15½— 16½	15 — 16	15½	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 —104 %	...	...
60,710£	Direct United States Cable	20	3¼%	3½%	3 %	11½— 12	11½— 11⅞	...	...
111,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	97	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	148 —153	145 —150	149	146
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	96 — 99	96 — 99	97½	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	111 —116	111 —116	112½	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	14½— 15	14½— 15	15	...
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	... — ...	... — ...	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	... — ...	... — ...	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	112 —117	110 —115 xd	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	99 —102 xd	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5¼%	5¼%	11¼— 11⅜	11¼—11⅜	11⅜	...
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15 — 15½	...	...
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½ %	...	31 —33	31 — 33	...	...
84,300	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	98 —101	98 —101	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	52 — 56	52 — 56	51½	51
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	105 —108	105 —108	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	...	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4⅞— 5⅛	4⅞— 5 xd	4⅞	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	12 — 14 xd	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14 xd	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5¼	4⅞— 5¼xd	...	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	97 —100	97 —100	98½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	125 —130	...	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4⅜— 5¼	4⅜— 5¼	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	5 — 5¼	5 — 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs.	100	...	...	...	98 —101	98 —101	100½	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red.	Stock	...	...	...	... — ...	... — ...	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14¾— 15¼	14¾—15¼ xd	15	14¾
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	...	...	...	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph	10	⅜%	2 %	⅜%	⅜— ⅞	⅜— ⅞	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	...	...	6½— 7½	6½— 7½	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	...	...	6 — 7	6 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref.	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9½— 10⅝	9⅝— 10⅝	10⅝	9⅜
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5¾	5½— 5¾	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6¾— 7½	6¾— 7½	7	6 1/16
150,000	Do. do. do. % Deb. Stock Red.	Stock	4½%	...	...	107 —110	107 —110	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000	10	10 %	6 %	4 %	8 — 9	8 — 9	8⅜	8½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	11½—12½ xd	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	122 —127	123 —128	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11½— 12½	11½— 12½	11⅞	11¾
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	108 —111	107 —110	...	...
26,100	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	4½	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	99 —102	99 —102	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1 — 1½	1 — 1½	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	4 — 4½	4 — 4½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —100	98 —100	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	14 — 15	14½— 15½	14⅝	14 3/16
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	111 —114	111 —114	...	...
220,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 98	96 — 98	...	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15 xd	14½	14 7/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8 — 9 xd	8¼	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2¼	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95 xd	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	3⅜— 4¼	3 — 4	3½	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	12 %	13 %	12½— 13½	12½— 13½	12¾	...

* Subject to Founders Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation July 25th.	Closing Quotation Aug. 1st.	Business done week ended Aug. 1st, 1900. Highest.	Lowest.
		‡							
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	20 %	...	2⅜— 3¼	2⅜— 3¼	2⅞	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —101	96 —101	...	...
30,000	British Electric Traction	10	...	6 %	...	14 — 15	14 — 15	14⅜	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12¾	12⅜
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	123 —126	123 —126	125	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	⅜— ⅞	⅜— ⅞	...	...
50,000	† Do do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	1/16— 1/16	1/16— 1/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	15 %	15 %	20 %	11½— 12½	11½— 12½xd	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,000 ...	5	...	...	...	5⅝— 6¼	5⅝— 6¼xd	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	3 %	5 %	...	1⅞— 1⅞	1⅞— 1⅞	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2 — 2¼	2 — 2¼	2⅛	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	109 —114	109 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red	Stock	...	...	...	101 —103	101 —103	103	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½%	15 %	15 %	13 — 14	13 — 14	13¼	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5¼— 5⅜	5¼— 5⅜	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	S ock	...	...	...	110 —114	110 —114	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	9 — 9½	9½— 10	9⅜	8 13/16
61,033	Do. do. Pref. half-shares	5	...	...	...	4½— 5	4½— 5	...	..
71,447	Do. do. Def. do.	5	...	...	...	4½— 5	4½— 5	4¼	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	57 — 60	56 — 59	58	57
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	6 — 7	6 — 7	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	7½%	3¾— 4¼	3¾— 4¼	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	2 — 2½	2 — 2½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	6 %	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	91 — 93	91 — 93	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼xd	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000	2	7 %	7 %	...	3 — 3½	2⅞— 3¼xd	...	...
140,300	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	13 — 14	13 — 14	13 1/16	...
30,000	Do. do. do. 4½ % Pref	5	7 %	7 %	...	5¼— 5⅜	5¼— 5⅜	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21⅝	21
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3¼%	3⅜%	9¼— 9⅜	9¼— 9¼	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13 — 13½	13 — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35 — 39	35 — 39xd	...	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	101 — 104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10 — 11	10 — 11	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5¼— 5⅜	5¼— 5⅜	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	93 — 96	93 — 93	...	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 104—106.
National Electric Free Wiring, 12/6 paid, ⅜—¼.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17½—18½.
Do. do. Pref. (£10 pd.), 10—11.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 % £5 (fully paid), 7—7½. Debentures, 102—104. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 17¾.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, August 1st.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33	£33	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17	£17	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25 10	£25 10	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3½d.	3½d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	68/-	68/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£8	£8	..
a ,, Bichromate, casks ..	per lb.	3¼d.	3¼d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £150	£80 to 150	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8¾d.	8¼d.	..
c ,, Wire, basis	per lb.	8½d.	8½d.	..
c Copper Tubes (brazed) ..	per lb.	11¼d.	11¼d.	..
c ,, ,, (solid drawn) ..	per lb.	11d.	11d.	..
g Copper Bars (best selected) ..	per ton	£84	£83 10	10s. inc.

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£84	£83 10	10s. inc.
g ,, Rod	per ton	£84	£83 10	10s. inc.
c ,, (Electrolytic) Bars ..	per ton	£81	£82 10	£1 10 inc.
c ,, ,, Sheets ..	per ton	£90	£90	..
c ,, ,, Rod ..	per ton	£84	£84	..
c ,, ,, H.C. Wire	per lb.	9½d.	9½d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	..	..	..
h India-rubber, Para fine	per lb.	3/10½ to 4/0½	3/10 to 4/-	½d. dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	68/6	69/6	1s. inc.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£12 15	£13	5s. dec.
g Lead, English Ingot	per ton	£18 2 6 to £18 5	£18 to £18 5	..
g ,, ,, Sheet	per ton	£18 15	£18 15	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 10	£9 10	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, st. ip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 13 6	£3 13 6	..
p Silicon Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15 to £40	..	..
i ,, ,, in bars		£53	£58	..
g Tin, block	per ton	£146 to £147	£147 to £148	£1 dec.
g ,, foil	per lb.	1/9	1/9	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand ..	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb b'ndl's	per lb.	8½d.	8_d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5⅝d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14	£14	..
k Zinc, Sh't. (Vielle Montague ond.)	per ton	£24 5 nett.	£24 5 nett.	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* **Messrs. Frederick Smith & Co.**

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* **Messrs. Henry C. Yeo & Co.**

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* **The Phosphor Bronze Company, Ltd.**

ON THE PHOTOMETRY OF ARC LAMPS.

By F. W. CARTER, M.A., Cantab.

(*Concluded from page* 129.)

We have seen how the ordinary methods of carrying out the photometry of arc lamps can be put on a more or less satisfactory basis, and made to yield results as accurate as the nature of the tests will allow. It now remains to describe certain arrangements which will reduce the labour of the observations to a minimum, and diminish the time required to make a test by more than three-fourths, besides requiring much less skill on the part of the observer than is needed in the older and more usual methods.

I may state at the outset that the apparatus to be described gives only relative results—it gives the *shape* of the polar curve and not the absolute candle-power in any direction. Accordingly it is necessary to find the candle-power in *one* direction, in order to reduce the relative to absolute results. If the one direction chosen is the horizontal, we can take this observation very much as we should with a glow lamp—except that a "distinctness" photometer must be used—putting the lamp at one end of a long bench and the standard at the other, and taking the mean of perhaps a dozen observations. This will be very little more trouble than the necessary process of calibrating the standard in the method already described—a process of the same nature, since the results are only relative until the apparent candle-power of the standard is known.

The method to be described has the following advantages over the usual methods:—(1) The lamp does not require moving during the test; (2) the photometry is not complicated with the colour difficulty, since we use light from the arc in our standard of comparison; (3) the variations of the arc cause very little trouble, since our standard varies with the arc: in fact, care is taken that the standard is composed of light taken, as nearly as possible, from the same side of the arc as that under test, since the photometric surface is generally anything but symmetrical, on account of the crater being often formed at the side of the carbon. This detail aids considerably in making the variations of the arc of small moment.

The apparatus is shown in plan in fig. 7, and in elevation in fig. 8, whilst the front elevations of the two chief parts, marked A and B, are shown in figs. 9 and 10. The light emitted in any required direction by the lamp L, is reflected at the three mirrors, M_1, M_2, and M_3, and finally caused to pass along the path of the photometer head. The angles of incidence are always 45°, so that the absorption of the mirrors remains constant. The mirrors M_2 and M_3 need only be a half the linear dimensions of M_1, which is some 2 feet 10 inches by 2 feet. M_1 is fixed rigidly to its arm, which turns about a horizontal axis passing through the arc. M is supported at the end of an equal arm, which turns about an axis collinear with that belonging to M_1. These two arms are always set parallel. The centre of M_3 lies on the path of the photometer. The mirrors M_2 and M_3 have to face one another. This is effected by mounting them on tubes which can turn in their bearings, and joining the other ends of these tubes by the pair of sliding rods shown in figs. 7, 8, and 10. The distance M_2, M_3 varies with the position of M_3, and, in order that we may not have to find the length of the path of the light afresh for every position of M_3, it is arranged that, when the distance, M_2 M_3, is increased by any amount, the distances M_1, M_2 and M_3 P are each decreased by a half of that amount. This is effected by making the tube-mounts of M_2 and M_3 to slide back and forth in their bearings, their positions being fixed by means of the inextensible cord seen in figs. 7, 8, and 10, which is attached to the bearing of M_2, passes through a ring at the back end of the tube-mount of M_3, through another at the back end of the mount of M_3, and is attached to the bearing of M_3. Accordingly when the distance M_2 M_3 is increased by any amount, the back ends of the tubes supporting the mirrors, M_2 and M_3, are pulled towards their respective bearings by a half of this amount. Thus we can divide the bench to read distances from the arc directly. To adjust, we have only to clamp the arm supporting M_1, at the required angle with the vertical, as shown by the divided circle seen in fig. 9, clamp the arm supporting M_2 at the same angle, as indicated by its divided circle, seen in fig. 10, and push the mirrors, M_2 and M_3, back as far as the cord will permit. On the screen which cuts off the direct light of the lamp from the photometer is fixed, just in advance of the edge of the mirror, M_1, a funnel, stopped at the farther end with a plate of milk glass, S, fig. 7, which can be more or less covered by means of stops. A vertical mirror, M_4, at an angle of 45° with the bench, forms an image of this plate in a line with the path of the photometer head. This arrangement forms the standard of comparison, its effective value being proportional to the area of the stop used. The various stops are necessary in order to bring the place of balance always on the bench.

Fig. 9.

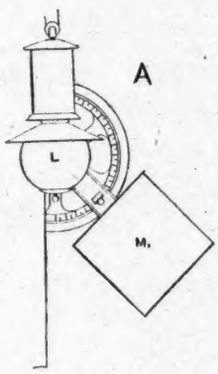
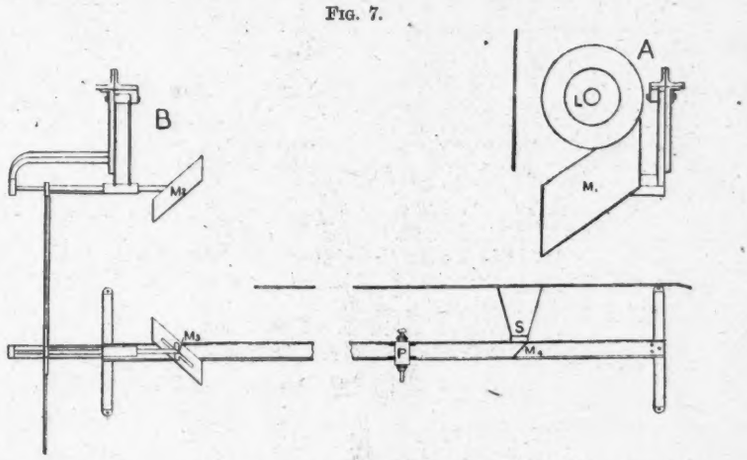


Fig. 7.



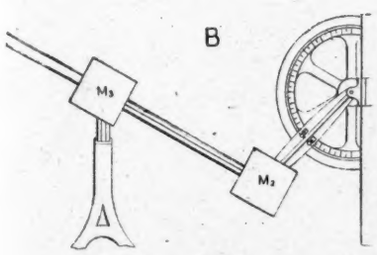


Fig. 10.

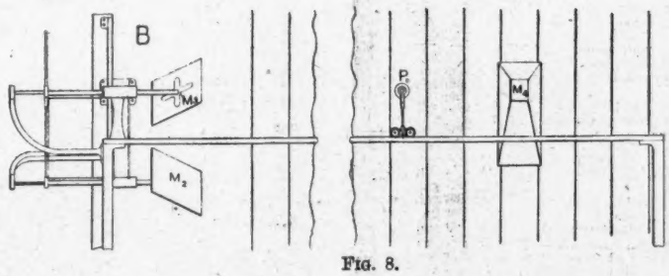


Fig. 8.

If a be the effective distance of the arc from the photometer, b that of the standard, and S the effective value of the standard, then, for each position of the mirrors we find the value of $(a/b)^2$ S—the relative candle-power. If I_0 be the absolute candle-power in the particular direction in which it has been measured, and a_0, b_0, S_0, corresponding values of a, b, and S for that same direction, then the absolute candle-power, I, in any direction is,

$$I = \frac{I_0}{S_0}\left(\frac{b_0}{a_0}\right)^2\left(\frac{a}{b}\right)^2 S,$$

that is, we multiply each relative candle-power by the constant quantity $I_0 b_0^2/S_0 a_0^2$ to obtain the corresponding absolute candle-power. Thus the calculations are of the simplest description.

Where absolute results are not required, as in determining the relative values of different carbons, or finding the absorption of a globe, it is sufficient to find the apparent candle-power of the arc in a particular direction, or that of the standard, S, by comparison with some independent light whose constancy can be relied on. Taking the candle-power of this light as unity, we calculate the mean spherical candle-power, or mean hemispherical candle-power in the manner detailed above, and compare the results so obtained.

Where absolute results are wanted for several lamps, the most convenient procedure is to find the absorption of the mirrors, and by means of an absolute standard (*e.g.*, a pentane lamp or an accurately standardised glow lamp), and a distinctness photometer, find the candle-power of the arc in one particular direction, taking the mean of many readings to obtain a true average. To find the absorption of the mirrors, we have simply to take two lights whose real relative candle-powers are known, and find what their apparent relative candle-powers are when one is put in the position of the arc, and the other at the *standard* end of the photometer bench.

The following method will, however, give the absorption more accurately, and will at the same time allow for any want of symmetry in the photometer:—Take two constant lights, L_1 and L_2, about equal to one another (*e.g.*, two 32-C.P. glow lamps run in parallel); put one (L_1) at the place for the arc, and the other (L_2) at a few feet beyond the *standard* end of the bench. Let a be the effective distance of L_1, and b the distance of L_2 from the point of balance of the photometer, and let R be the multiplier which converts the apparent into the real candle-power, so that the apparent candle-power of L_1 is L_1/R.

Then $$\frac{L_1}{R\,a^2} = \frac{L_2}{b^2};$$

Now interchange L_1 and L_2, and let a', b' be the new values of a and b; then

$$\frac{L_2}{R\,a'^2} = \frac{L_1}{b'^2};$$

multiplying these equations, we get

$$\frac{L_1 L_2}{R^2 a^2 a'^2} = \frac{L_1 L_2}{b^2 b'^2}, \text{ or } R^2 = \left(\frac{b\,b'}{a\,a'}\right)^2, \text{ or } R = \frac{b\,b'}{a\,a'},$$

giving the required multiplier independent of L_1 and L_2. It cannot be assumed that R remains constant over long periods, as it depends chiefly on one very variable factor, the dirtiness of the mirrors.

The form of apparatus just described reduces the difficulties of arc lamp photometry to a minimum, and in conjunction with a "distinctness" photometer and a reliable primary standard, is capable of quickly giving results of a definiteness and accuracy only obtained in the older methods by the expenditure of considerable time, and the exercise of the greatest care and judgment. Furthermore, the arrangement is much more compact than the older forms, whilst the bench and photometer are quite suitable for all tests of glow lamps.

Electricity in Agriculture.—A question was recently asked in the House of Commons about the experiments made by Mr. O'Sullivan in County Limerick, on the alleged improvement in the potato crops by the agency of atmospheric electricity. It was stated that experiments on a larger scale were in progress.

MOTORS.

By CLAUDE W. HILL.

In designing motors for some classes of work, it is necessary to take into account not only the average H.P. which the motor is to develop, but also the maximum torque which it is to exert. Where no limit of current is specified, the average H.P. only need be considered; but in cases where a

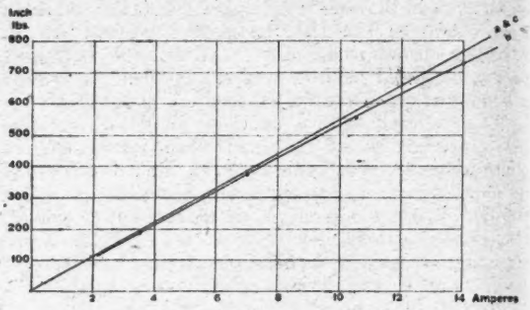


Fig. 1.

machine is specified to give a maximum torque with a current not exceeding a given figure, then the specified torque and current must be taken as the basis of the design.

Taking the well-known formulæ, torque in inch-pounds, $= \frac{63{,}025 \text{ H.P.}}{S}$, and H.P. $= \frac{E\,i}{746}$ (in which E = back E.M.F., and i = total current through motor armature), and combining them we get

$$\text{torque} = \frac{84{\cdot}48\ E\,i}{S} \qquad (1)$$

or

$$S = \frac{84{\cdot}48\ E\,i}{T} \qquad (2)$$

This formula shows that there is a certain speed for which a motor must be designed, in order to fulfil fixed conditions as to voltage, current and torque, and it further shows that

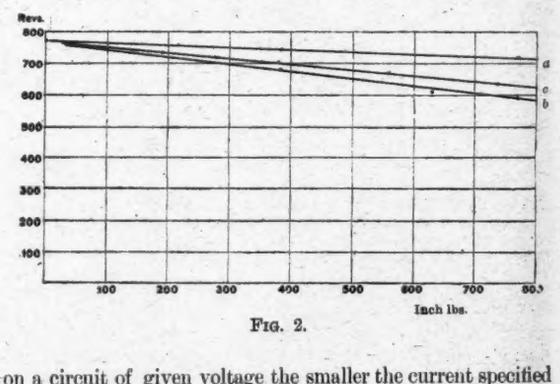


Fig. 2.

on a circuit of given voltage the smaller the current specified for the production of a given torque, the slower must be the speed (and therefore the larger the size) of the motor.

Formula No. 1 may be stated in another way. Taking $E = \frac{N\,C\,S\,p}{10^8 \times 60 \times \cdot5\,d}$, in which N = flux through one pole, C = total conductors around armature, p = number of pairs of poles, and d = number of current paths, and substituting this in formula No. 1, we get—

$$\text{torque} = 1{\cdot}408\ N\,C\,p_1\,i_1\,10^{-8} \qquad (3)$$

in which p_1 = number of poles, and i_1 = current per conductor.

Take the case of a motor to run on a 500-volt circuit, to develop 4 B.H.P. as an average, and to exert a maximum torque of 770 inch-lbs. with a current not exceeding 14 amperes. The speed of the machine must be (by formula 2) 720 revolutions per minute, the back E.M.F. being 467·5.

If instead of starting with formula No. 2 we start with formula No. 3, and calculate the value of N and C, we shall

find that these values correspond to a speed of 720 revolutions with a back E.M.F. of 467·5.

There is no advantage in adopting a higher speed for the average H.P. as the size of the machine is governed by the torque and current.

Thus if the machine were specified to give 4 B.H.P. at 1,400 revolutions with maximum torque and current as before, the carcase would still have to be of the size found by formulæ Nos. 2 and 3. It would have to be over-compounded, the shunt and series winding together giving 1,400 revolutions at 4 H.P., and the series winding being sufficient to bring the speed down to 720 with the specified current. No gain would be effected in the size or price of the machine, the regulation would be bad, and the ratio of the reduction gearing would be increased with consequent loss of efficiency.

Where a steady speed is demanded and hand regulation is not possible, provided the supply pressure is maintained constant at the motor terminals, shunt winding will give the most satisfactory results, but where the leads are long and the fall of voltage appreciable, the magnet will be weakened, the specified current will be exceeded and there may be sparking. Compound winding should then be adopted, the series winding being proportioned to compensate the drop of volts on the shunt coil and so maintain a constant strength of magnet. The regulation will not be so good as with the shunt motor working on constant pressure, but the result obtained will be better than with the shunt machine working with varying pressure.

These points are illustrated in the accompanying curves of the machine mentioned above.

Fig. 1 is the curve of torque and current: (*a*) being for the shunt machine on constant pressure; (*b*) for shunt machine with a fall of 15 per cent. in the voltage at maximum current; (*c*) for compound machine with the same fall. It will be noticed that (*a*) and (*c*) coincide.

Fig. 2 gives the curve of torque and speed under the same conditions.

CURRENT SPECIFICATIONS.

XXIII.—GRAYS THURROCK ELECTRIC LIGHTING.

SUMMARY.

Extent of Contract.—Supply and erection of plant for a complete electric lighting station. The contract is to be let in different sections, such as boiler house plant, accumulators, switchboard, generating plant, crane, &c., separate offers being sent in for each.

System Adopted.—Three-wire direct current system with accumulators, employing 460 volts between outers, and 230 volts between either outer and middle conductor.

Section dealt with.—In this *critique* only Section B., referring to steam dynamos, balancers, and boosters, is dealt with.

Number and Size of Steam Dynamos.—Two, each to easily develop 100 KW., *i.e.*, not exceeding 200 amperes at any E.M.F. between 460 and 500 volts.

Speed Specified.—Not to exceed 400 revolutions per minute.

Conditions of Working.—Steam dynamos to give above output with 150 lbs. square inch pressure, working either condensing with 25 inches vacuum, or non-condensing. At first to work non-condensing.

Type of Engine.—To be two-crank, compound, of the vertical high speed type.

Temperature Rise of Dynamo.—After six hours full load run, the temperature rise of any part of armature windings not to exceed 60° F., or of magnet winding 70° F.

Steam Consumption.—The steam consumption per KW.-hour at full and half load, working both condensing and non-condensing, to be stated in tender.

Balancer and Booster.—To consist of four machines directly coupled together.

Speed of Combination.—Not to exceed 1,000 revolutions per minute.

Output of Set.—Each of the two inner balancing machines to be capable of generating up to 30 amperes at 250 volts = 7·5 KW. Each of the two outer booster machines to be suitable for developing up to 42 amperes at 90 volts = 3·78 KW.

Temperature Rise.—Same as for large dynamos.

Specified Date of Completion.—To be given in tender.

Penalty for Late Completion.—*One per cent.* of contract price per week.

Stipulations as to Removal of Foreman.—Satisfactory, see comments below.

Stipulations as to Wages paid to Workmen.—Acceptable.

Terms of Payment.—60 per cent. as delivered and erected: 20 per cent. on engineer certifying plant is ready for use for public supply; 10 per cent. on completion of official test 10 per cent. six months later.

Arbitration Clause.—Of limited application, see comments below.

Date for Receipt of Tender.—August 9th, 1900.

This specification is signed by Messrs. Preece and Cardew, the consulting engineers to the Council, and so far as the technical particulars are concerned, may be taken as a model by less eminent engineers. The requirements are clearly stated, and tenderers must state in their offers exactly what they propose to supply, the dates by which they can guarantee completion, and the guarantees they are prepared to enter into. Except for the stipulation that the engine must be of the two-crank vertical type, the specification is entirely open, and no manufacturer need hesitate to offer his standard apparatus.

Detailed drawings are to be submitted with tender, but if desired, those accompanying rejected offers will be returned to senders. The general conditions have evidently been prepared with great care, and in some respects are admirable, though, as at present drafted, we cannot advise manufacturers to accept them in their entirety.

Clause 4, relating to extensions of the time of completion, is all that can be desired. It states:—

> The contractors shall, *bona fide*, commence the erection of the works on or before the .....day of .....next, and complete the whole of the works, including additions or modifications (if any), by the .....day of .....190.... If the act of God, war, insurrection, rebellion, strikes, or combinations of workmen, or any extraordinary or unforeseen circumstances which, in the opinion of the engineers, may be beyond the control of the contractors, shall in the opinion of the engineers cause unavoidable delay in the completion of the works, or any part thereof, they may extend the time for such completion, and shall accordingly allow a reasonable extension of the same. If the engineers, in exercise of any power vested in them by these presents shall substitute in writing a later date for the completion of the works, the contractors shall complete the same by or before the substituted date as though the same had been originally inserted in these presents.

A period of eight weeks from the signing of the contract is allowed for the preparation of all foundation drawings, and particulars of any other work which may have to be done by the Council under the terms of the contract. It is distinctly stipulated that all responsibility for the accuracy of these drawings and particulars rests with the contractor, and "no compensation or allowance shall be made in respect" of any liability which may accrue to the contractor by reason of any errors therein. The following clause (No. 12), dealing with access to factories by engineer or his representative, is also very satisfactory:—

> The engineers and such assistants as they may require or appoint shall at all times during the progress of the works have free access to the site and to the factories and all yards and other places which shall, for the time being, be in the possession or occupation of the contractors for the purpose of this contract, and shall be entitled to inspect and test at all reasonable times any part of the works during the manufacture or before delivery of the same, whether at the factory of the contractors or of any company or firm or person employed by them, and the contractors shall afford every facility, and make all necessary arrangements for the engineers and their assistants when visiting, inspecting, or testing the works, and provide all materials, labour, instruments and power for any such inspection or testing, without extra charge.

There are four clauses which refer directly or indirectly to labour questions. They are of a distinctly fair character, and may be taken as the maximum to which a manufacturer can without loss of dignity or prestige agree. For these reasons we reprint them in full:—

> The contractors shall at all times during the progress of the works provide and employ constantly upon the works such and so many competent foremen and workmen, and at all times employ such labour of every description as shall, in the opinion of the engineers, be necessary for the due execution of the works.
>
> The contractors shall pay all persons engaged or employed by them on the works the rates of wages recognised in the district, and shall observe such hours of labour as are generally accepted as fair in each trade, and shall from time to time, whenever required so to do by the Council, produce to them such evidence as they may deem sufficient that they are paying such wages and observing such hours.
>
> If the engineers shall at any time consider any agent, engineer, foreman, or workman employed by the contractors for the purposes of the contract to be inefficient or objectionable, or the number of the workmen, or the amount or character of the plant, materials, and appliances then used and provided by the contractors in or upon or for the purposes of the works to be insufficient or improper, or that the works or any of them are not being executed with due diligence and despatch having regard for the time hereinbefore agreed to for

the completion of the works, then and in every or in any such case it shall be lawful for the engineers to give notice in writing to the contractors requiring them to dismiss any such inefficient or objectionable agent, engineer, foreman or workman and to appoint in lieu of such persons respectively other fit and proper agents, engineers or foremen, and to employ other workmen, and to provide other plant, materials or appliances, and also to make such additions to the number of agents, engineers, foremen or workmen employed, or to the plant, materials and appliances to be supplied by the contractors, or such change in their character either until the completion of all or any of the works or for a limited period, as the engineers may think necessary and shall by any such written notice require.

If the contractors shall not upon receipt of any such notice, or within a time to be specified therein comply with such notice, it shall be lawful for the engineers, on the account and at the cost of the contractors, to remove the agents, engineers, foremen, workmen, plant, materials, or appliances complained of, and at the like cost to provide and employ such other and additional agents, engineers, foremen and workmen for such time and to purchase and provide such additional or other plant, materials and appliances respectively as they may think necessary, and to pay such other or additional agents, engineers, foremen and workmen such salaries or wages, and to pay for such additional plant, materials and appliances respectively such prices as the engineers may think proper, all which salaries, wages and prices respectively if paid by the Council, and any additional expense the Council may incur in relation thereto, shall on demand be repaid to them by the contractors, or the Council may retain or deduct the same out of any monies then due or thereafter to become due to them under this contract.

The contractor is required to *dismiss*, and not "remove," which we contend is the right word to use in this connection, but steps are only to be taken by the engineer to replace such objectionable workmen after the contractor has had due notice of the engineer's wishes.

The maintenance clause requiring the contractor to be responsible for defects in workmanship and material for six months is acceptably worded.

Provision is made that in case of any contradiction in terms between the general conditions and the specification, the interpretation is to be decided by the engineer, but it is to be generally understood that the rendering most favourable to the Council is the correct one. The clause is rather curious, it reads :—

In case of terms or provisions repeated wholly or partially in this contract and in this specification *the Council may adopt both or either of such terms or provisions so as to secure in all cases the most ample protection*, and any discrepancy between this contract and the specification shall be construed or determined by the engineers in the manner which in their judgment is most in accordance with the general spirit and intention of this contract and the specification.

The principal defect in these conditions, as already stated, lies in the limited arbitration clause. It only permits disputes as to prices to be arbitrated upon, all points relating to the interpretation of the specification and the carrying out of the work being settled by the engineer. The clauses, as they stand, state :—

The decision of the engineers shall be final and conclusive, as to the manner of carrying out works, the quality of material, and workmanship and the meaning of any clause, matter or thing in the specification or any of the plans, sections or drawings of this contract.

In case, and so often as any difference or dispute shall arise respecting the cost of any work or prices to be paid, the subject of every such difference or dispute shall in every such case, on the demand in writing of either party, be referred to the sole arbitration and award of an arbitrator to be appointed by the President of the Institution of Civil Engineers for the time being, pursuant to the provisions of the Arbitration Act, 1889.

We strongly urge tenderers to protest against the inclusion of these incomplete arbitration clauses in contracts. Whatever be the reputations of the consulting engineers concerned, they are but human, and consequently may err. The contractor ought to have the right to appeal to an independent authority, for the engineer cannot help but be in a false position when called upon to decide in a judicial matter between a contractor and himself.

GLOUCESTER ELECTRICITY WORKS.

In another part of this issue we describe the Gloucester Electricity Works, which were opened on Thursday, July 19th, by the Mayor of that town. After the ceremony a large gathering of visitors inspected the station under the guidance of the consulting engineer, Mr. Robert Hammond, and the resident engineer, Mr. Walter J. Bache. In the evening a banquet in the Guildhall was given by the chairman of the Electricity Supply Committee (Councillor C. H. Clutterbuck), the consulting engineer, the architect, and the contractors, to a large company. The exigencies of space will not permit us to publish the speech of the Mayor, who, in a felicitous manner, proposed "Success to the Electricity Undertaking," coupled with the name of Mr. Clutterbuck, nor Mr. Robert Hammond's humorous reply to the toast of the "Consulting Engineer," and other locally interesting post-prandial orations.

Suffice it to say, that the good people of Gloucester should feel well satisfied that their interests are in the hands of a body of gentlemen who have clearly seen the advantage of securing the electric light to the city, and also of disposing of the town's refuse by the only rational means of destroying it thoroughly and most effectually from the sanitary point of view. The Corporation has been fortunate in securing the services of Mr. Robert Hammond, than whom nobody is more competent to advise on the requirements of a central station, and they may also be congratulated on the constructive work having fallen into the hands of a thoroughly representative and able body of contractors, the majority of the firms having long ago secured the thorough confidence of everybody connected with the electric lighting industry.

The order for extensions before the original plant had been in operation augurs well for the future, but if there should be any need to devise "means for stimulating the demand for electrical supply," the subject of two papers read before the Huddersfield Convention of the Municipal Electrical Association, we can only suggest that the Council again apply to Mr. Hammond, to whom, by the way, we offer our thanks for the loan of the blocks with which we illustrate the station equipment. The residents of nearly 200 towns in the United Kingdom are enjoying the privilege of using the best of all artificial illuminants, and although Gloucester is the last station to be opened, it is evident that it is by no means least, and it is equally certain that with Mr. Hammond to guide the enterprise it cannot but be successful.

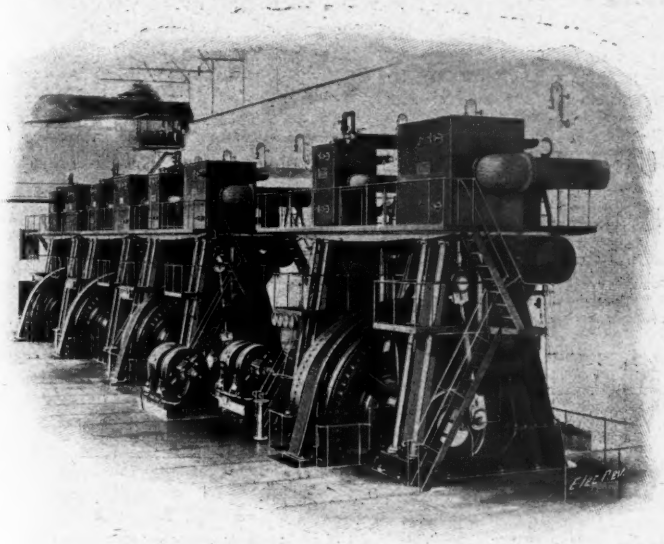
The newspaper press of Gloucester is deserving of special praise for the admirable manner in which the opening ceremony and the banquet were described, and we think that in functions of this kind generally it would not be altogether unbecoming to associate the name of a local journalist with the toast of "The Press," seeing how fully everything is dealt with by the local papers. The significance of what we say is emphasised by the following extract from the *Gloucester Journal* :—"The toast of 'The Press' was proposed by Alderman Matthews, but as the responses, as set out in the toast list, were confined to the electricity trade journals, the local representatives left." But the toast is always last on the list, just to show, we suppose, its utter unimportance. The pen is said to be mightier than the sword, and yet in nine places out of ten to which the technical journalist is invited, much valuable time is absolutely wasted by some retired half-pay officer, whose eloquence is usually limited to the words of command, getting on his hind legs and reiterating in a dull, listless, aimless, and irresponsible manner, that with which his hearers are already perfectly familiar, concerning the Handy Man, Tommy Atkins, and the Auxiliary Forces.

Everybody would gladly listen to a few blunt, brief, and manly sentences from a gallant soldier or sailor fresh from active service, but it generally falls to the lot of the retired warrior of a quarter-century ago to toast a subject on which the man in the street is often better informed. Or else somebody, unannounced on the toast list, comes forward presumably with good intent to give a 20 minutes recitation that nobody can hear owing to the hum of conversation, and which nobody would appreciate if silence reigned supreme.

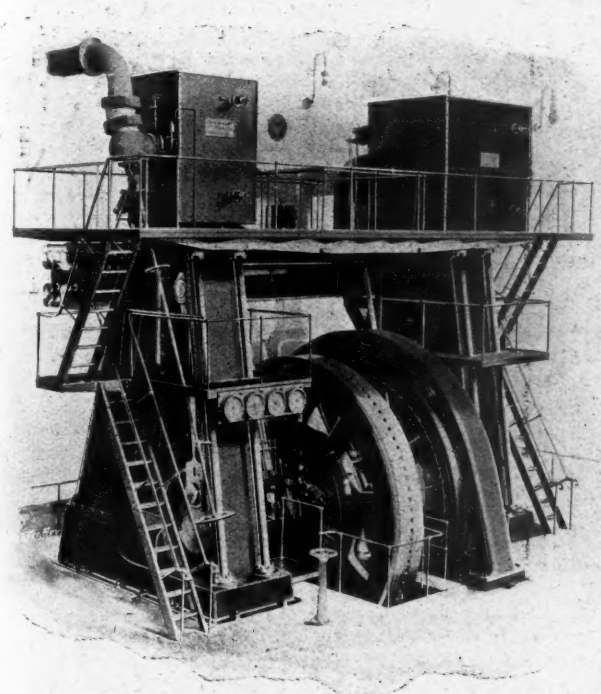
At all events, the technical press might well be eliminated from the toast lists of gatherings of mainly local interest, especially as the representatives of this section of the Fourth Estate usually express what they wish to say in their own pages. Indeed, it is questionable whether they should even be asked to speak in public on matters which they are expected to critically deal with immediately afterwards in the journals with which they are associated.

LARGE ENGINES FOR CENTRAL STATIONS.

The rapid increase in the demand for electricity supply which has everywhere been experienced, has led to the constant increase in the size of generating units, which have now attained to what a few years ago would have been deemed enormous dimensions. One of the illustrations herewith shows four vertical cross-compound condensing



Steam Alternators at Boston Electricity Works.



Single Set: 1,500-kw. Steam Alternator.

engines, direct driving alternate current generators, which have been installed in the Boston Electric Light Company's works. Another illustration is a view of a single set of the same size.

The engines, which were made by Messrs. McIntosh, Seymour & Co., Auburn, N.Y., have cylinders 28 inches and 58 inches in diameter, with 48 inches stroke, and run at 120 revolutions per minute. The steam pressure is 160 lbs. per square inch. The valves are of the gridiron type, with variable cut-off in both cylinders, controlled by the governor. At normal load, the engines are rated at 2,500 h.p. each, but are able to greatly exceed this if necessary.

The high pressure cylinders alone are steam jacketed, and there is a reheater receiver between the cylinders. The crankshaft is 26 inches diameter at the middle, and 21 inches at the journals, which are 42 inches in length. Each engine is provided with a fly-wheel 16 feet in diameter, and 100,000 lbs. in weight.

The generators, which were made by the General Electric Company, are of the three-phase type, with an output of 1,500 kw. each. For the purpose of paralleling, each engine is provided with an electrical governor, which can be controlled from the switchboard.

We are indebted to Messrs. McIntosh, Seymour & Co. for the photographs from which these illustrations were reproduced.

INSTITUTION OF ELECTRICAL ENGINEERS.

ALTERNATING CURRENT INDUCTION MOTORS.

By A. C. Eborall, Associate.

(*Paper read May 17th*, 1900.)

(*Continued from page* 159.)

With regard to squirrel-cage rotors, and to the modification of them, the rotor wire-wound with closed coils, there is not much to say. The chief difficulty with the former lies in the fact that it is difficult to make a good mechanical job of the connections to the end rings. If the motor bars are screwed to these rings, the contact between bar and ring is not only uncertain, but however good it may be at first, it is certain to deteriorate under the influence of the heavy rotor currents, and the heating and cooling of the rotor. Consequently, most makers sweat the rings over the projecting and flattened ends of the bars. But with this the rings will sometimes melt right off under overloads, splashing the solder all over the stator coils, and generally doing other damage. The author's firm brazé the rings on when a motor of this character is put to work of an exceptionally heavy nature, where overloads are the rule and not the exception, or when the starting conditions are severe. Messrs. Kolben get over the difficulty in the manner shown in fig. 6; here the rotor bars are connected to the short-circuiting rings by means of thin copper strips, used as radial connectors. The rings themselves are of bronze, and are of small diameter, but very massive; they are keyed directly on the shaft without any insulation whatever. In a communication to the author, Mr. E. Kolben states that he has found this construction to prevent entirely the evil mentioned above, and that it greatly assists his single-phase motors to start well—doubtless on account of the extra resistance in the strips. Mr. Kolben also uses this construction for larger motors for crane and similar work (where large starting torques are required without, if possible, the employment of a starting resistance) as it allows of the insertion of resistance strips of brass or other material, in place of the copper connectors.

Several firms, notably the Oerlikon Company, avoid the squirrel-cage construction altogether, by winding the rotor with closed coils. In this case the rotor winding may either consist of a regular wave winding, taken all the way round either once or else several times and finally short-circuited, or better, of a number of coils, or groups of coils, separately short-circuited. Such wire-wound rotors are naturally more expensive than either of the forms described above, and are frequently difficult to wind, on account of the trouble experienced in handling the heavy conductors.

The employment of wound rotors and non-inductive starting resistances is, as already indicated, always preferable for motors of any size. Here the rotors are invariably wound with a three-phase star-connected drum winding, which may be carried out either with overlapping (rectangular) coils, or with two or four bars per hole or slot, arranged as a cylinder wave winding.

The common junction to the three phases of such a winding is frequently the ironwork of the rotor. This is very convenient with motors of considerable size, where the conductors are usually massive. Star-connected bar windings of this character are always unsymmetrical, and "false connections" have to be made in each phase.

A point to be remembered when designing wound rotors for

high tension motors is the fact that the rotor volts per phase (that is, the voltage between any two slip-rings at normal stator pressure when the brushes are lifted off and the motor is at rest) must be kept down to a safe value; this is because at starting, with all resistances in, the voltage across each resistance (and the corresponding two rings) may be sufficiently large to be a source of danger to the attendant, if the turns in the winding have not been kept down; moreover, there is some risk of arcing taking place. On the other hand, in no case must the number of rotor conductors in series be too few, especially if the motor is of large size, else the cost of the starting box becomes excessive, and if this latter is mounted on a switchboard, the three heavy cables coming to the latter may become inconvenient to arrange for; moreover, the contacts on the box may give trouble. It may sometimes happen that it is desirable to regulate the speed of a polyphase motor (by means of the rotor resistance) at a point situated a considerable distance away from the motor. In such a case, and if the motor is for a low voltage, it may pay to arrange the rotor windings to transform up, as it were, in order to effect a saving on the cost of the three cables coming from the rings to the starting box, but this must not be pushed too far.

7. Weight per B.H.P.—The net weight per B.H.P. (that is, not including the weight of the rails, pulley, and starting resistance, if any) of the five representative motors designed and constructed on the above lines will not come out much below the following values:—

	2	5	10	25	50 B.H.P.
Polyphase motors ...	80	58	56	40	40 lbs.
Single-phase motors ...	115	88	66	62	62 „

NOTE.—The values given in Nos. 1 to 7 above are for 50 cycle motors at voltages of 110, 220, 440, or 500 volts, having the following number of stator poles per phase:—

All motors between 2—7½ B.H.P. inclusive,	four	poles.	
Do.	10—30	do.	six „
Do.	40—100	do.	eight „

The various values, however, for 40 and 60 cycle motors having the same number of poles are practically the same as those given above.

A standard line of induction motors constructed on the lines already indicated, and to which the above figures relating to performance apply, would have the following general technical data.

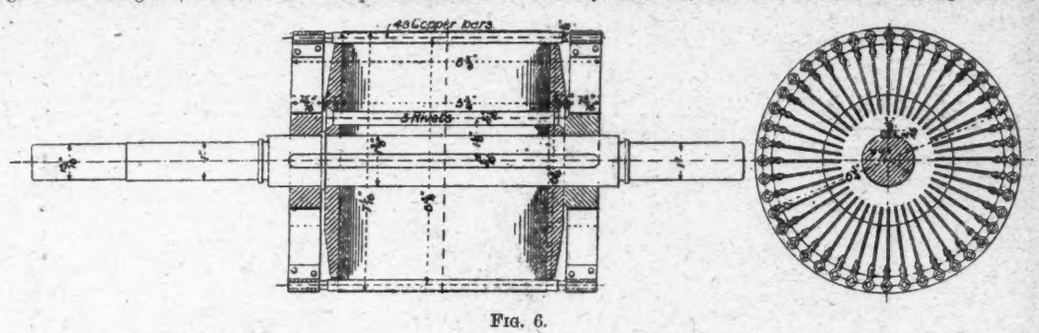


FIG. 6.

Although it is the standard practice with one or two firms to build the starting resistance within the rotor itself, instead of employing a separate starting box and slip-rings, it would seem that the latter practice is the better. The advantage of doing away with the external arrangement consists, of course, in getting rid of the sliding contacts; on the other hand, it is easy for the short-circuiting device (whether operated by hand through the hollow shaft or automatically) to get out of order, inspection of the contacts is difficult, and, above all, the motor is brought up to speed abruptly, because a subdivided resistance is practically out of the question. Consequently, the effect on the pressure regulation of starting a motor so fitted under heavy load is bound to be greater than if the motor had been fitted with an external graduated resistance, permitting of easy and gradual starting. However, several firms are now engaged in studying this detail, and considerable improvements may be expected shortly in the electrical and mechanical design of internal starting gear.

(c) *Notes on Performance and Design.*—An analysis of the guaranteed performance of a given line of open or semi-enclosed induction motors between 2 and 100 B.H.P. built by any of the best Continental or American makers, and whose construction is on the lines indicated above, may be set forth as follows:—

1. No-load Current.—Expressed as a percentage of the full-load current, the values for this will be as under:—

			Poly-phasers.		Single-phasers.
For motors between 2—5 B.H.P.	inclusive		30 %	...	40 %
Do.	7½—20	do.	25 %	...	30 %
Do.	25—100	do.	20 %	...	25 %

2. Overload Capacity.—This is sensibly the same for all sizes with a given line of motors run at constant stator pressure, and will be as follows:—

	Polyphasers.	Single-phasers.
For one hour * ...	50 %	Varies considerably, but generally small.
Before falling out of step ...	90 %	

3. Full-load Drop of speed (Slip).—At constant pressure on the stator terminals this will be:—

For induction motors between 2—5 B.H.P.	inclusive		7 %
Do.	7½—15	do.	5 %
Do.	20—40	do.	4 %
Do.	50—100	do.	3 %

4. Heating.—The final temperature rise after a long continuous run at full load will not exceed 40° C. for semi-enclosed motors having outputs between 2 and 25 B.H.P., and 30° C. for larger sizes.

5. Full-load Efficiency.—For semi-enclosed motors with hot windings the values for five representative sizes will be as follows:—

	2	5	10	25	50 B.H.P.
Polyphase motors ...	75 %	79 %	85 %	87 %	90 %
Single-phase motors ...	73 %	77 %	83 %	86 %	89 %

6. Full-load Power-factor.—The values for this quantity for five such representative motors will be:—

	2	5	10	25	50 B.H.P.
Polyphase motors ...	78 %	80 %	85 %	87 %	88 %
Single-phase motors ...	72 %	75 %	80 %	83 %	85 %

* The temperature rise not exceeding 70° C. for semi-enclosed motors, and less for open-type motors.

1. Peripheral Speeds:—4,000 to 7,000 feet per minute, according to the size of the motor.

2. Ampere conductors per inch of stator (inner) periphery at full load.

B.H.P.	Ampere conductors per inch.
2 to 7·5	250
10 to 30	330
40 to 100	430
100 to 150	570
Above 200	600

3. Flux Densities per square inch.—In the stator teeth:—

B.H.P.	Maximum value of B.
2 to 7·5	65,000
10 to 30	70,000
40 to 100	80,000
Above 100	85,000

In the rotor teeth:—

B.H.P.	Maximum value of B.
2 to 7·5	80,000
10 to 30	85,000
40 to 100	90,000
Above 100	100,000

In the air-gap the flux density should never exceed 30,000 lines per square inch. The flux density in the stator core is determined solely by the permissible loss, and does not otherwise affect the performance of the motor.

The above figures give very good results for 50 ~ motors having partly closed slots for both rotor and stator. With motors for higher frequency, and for hole-wound stators and rotors, smaller values must be taken.

4. Current Densities per square inch.—With low and medium pressure semi-enclosed motors, the amperes per square inch in the stator windings at full load will be between 1,500 and 1,100, according to size, while in the rotor bars the current density will be about 15 per cent. higher. With high pressure motors somewhat smaller values must be taken in the stator on account of the relatively larger space taken up by insulation.

5. Length of Air-gap.—This is always to be made as small as possible, and is determined wholly by mechanical considerations. Usual values for the length of air-gap, that is, the distance from iron to iron, are:—

Rotor diameter.	Air-gap length.
Up to 4 inches inclusive	1/100 inch.
Between 5 and 8 inches inclusive ...	1/75 „
„ 9 and 12 „ ...	1/50 „
„ 15 and 20 „ ...	1/32 „
„ 24 and 32 „ ...	1/16 „
„ 40 and 60 „ ...	1/8 „

Although the above figures relating to the design of induction motors have been taken wholly from practice, it is perhaps necessary to point out that it is not possible to apply hard and fast rules and constants when designing such motors; experience in designing, and a large quantity of experimental data for the type in question, are absolutely necessary if the best results are to be obtained.

PART II.

Starting Devices for Single-Phase Induction Motors, and some Notes on Recent Developments.

It is not too much to say that more attention has been given to the question of starting devices for single-phase induction motors than to any other problem connected with single-phase working. The first difficulty was to get such motors to start at all; then after this was overcome, there came the question of reducing the heavy starting current; finally, it was sought to so improve the starting device as to permit of the motor starting against load, still with a moderate current consumption. In the six years during which the subject has been before electrical engineers, successive improvements have taken place, and it is to the latest development in single-phase motors that the author wishes more particularly to refer in this part of his paper, namely, the new motor of Mr. Alex. Heyland. Before doing so, however, it may perhaps not be out of place to consider very briefly the underlying principles of all single-phase induction motors, although, of course, there is nothing new to be said on the subject in these days.

It has already been stated that a single-phase induction motor is nothing more than a polyphase motor running on one phase. Let, for instance, a two-pole two-phase motor be running from two-phase mains without load. Neglecting (as may quite well be done) the trifling power current required to make up the motor losses (under these circumstances practically only iron, ventilation, and friction), the current read on an amperemeter in each phase is the "magnetising current" of that phase of the motor—that is, it is the wattless current required for driving the magnetic flux through the magnetic circuits of the motor; further, the speed is synchronous. Now let one phase be switched out. The motor will go on running as a single-phaser at practically the same speed, but the amperemeter in the remaining phase will read approximately twice the current that it did before—that is, the magnetising current in this phase has doubled. What has happened is briefly as follows:—The magnetic flux originally provided by the switched-out phase is now replaced by a flux of approximately the same value and relative position furnished by a magnetising current in the rotor. Magnetising currents are called into being in the rotor, induced by the magnetic flux of the phase still connected to the mains, and in quadrature with this flux with regard to time, and these currents are carried round nearly 90° in space by the practically synchronous rotation before reaching their maximum. Thus the cross-flux produced by them has very nearly the same effect as that formerly produced by the switched-out phase. The magnetising current in the rotor has, of course, to be balanced by a corresponding stator current, so that the amperemeter reads the magnetising amperes of phase 1, plus the magnetising amperes of the rotor transferred to the winding of phase 1. Hence the magnetising current in the latter approximately doubles.

With this perfect motor running at synchronous speed, it would be found that a voltmeter connected to the terminals of the switched-out phase would give a reading equal to the pressure on the mains from which phase 1 is running. This E.M.F. is that induced by the cross-magnetisation of the rotor magnetising currents, and is in quadrature with the impressed E.M.F. of phase 1, as already stated. In commercial motors the E.M.F. of phase 2, measured in this way, is not quite equal to that of phase 1. The magnitude of the difference between the two voltages is a measure of the quality of the design of the motor.

It has been said above that the motor continued to run as a single-phaser at practically the same speed. In reality the speed is a trifle less (the difference being too small to detect on a counter), owing to the fact that the rotor currents cause a slight slip, so that even a single-phase motor without friction and ventilation losses (unlike the polyphase motor) cannot run at a synchronous speed at no load.

Of course, as the rotor is loaded, the rotor power currents called into being by the load are magnetically balanced by corresponding stator currents (when the rotor and stator coils are co-axial, or approximately so) and the slip increases, that is, the speed departs more and more from synchronism. Owing to this latter circumstance the induced rotor magnetising currents are carried round in space less than 90°; the cross-magnetisation produced by them is accordingly shifted from the most effective position, until with continually increasing load there comes a point at which the torque due to the cross field and the rotor load currents attains a maximum value—if this value is exceeded the motor pulls up. When the rotor is stationary, the cross-magnetisation is reduced to zero; there remains now only the one flux of the phase connected to the mains (phase 1), and this flux cannot possibly produce a torque—that is, the motor cannot start—because its axis (that is, the axis of the exciting coils of phase 1) coincides with the axis of the current-carrying coils of the rotor.

In order, therefore, to enable a single-phase induction motor to start at all, an auxiliary starting field must be created that will do exactly the same thing as the rotor magnetising currents do at synchronous speed. That is, with regard to space, a magnetic flux must be established in quadrature with the principal flux inducing the rotor currents; and with regard to time, this auxiliary flux must coincide with the rotor load current—that is to say, it must be approximately 180° behind the corresponding stator current. Every single-phase induction motor must therefore be provided with a device to produce a suitable cross-flux in the air-gap, and the amount of starting torque available will depend purely upon the value of this cross-flux, and upon the effectivness of its time relations as stated above.

All single-phase induction motors are provided with starting coils wound in the useless winding space of the stator. They rarely occupy more than one-third of the total stator winding space, and frequently less; moreover, these coils are invariably so arranged that the magnetic axis of each coil is in quadrature* to the magnetic axis of the corresponding running coil—a disposition exactly fulfilling the "space" requirements stated above. The difference existing between the various starting devices lies mainly in the various methods of producing the requisite phase relation of the cross-magnetisation.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this journal by W. P. Thompson & Co. Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

12,722. "Improvements in and relating to arms and trolleys for overhead electrically-driven tramcars." J. T. Pearson. Dated July 16th.

12,827. "Improvements in electric switches." E. E. Bartlett and J. E. Robinson. Dated July 17th.

12,838. "A 'safety' carbon holder and carbon economiser for use in electric arc lamps." J. W. Ferrier. Dated July 17th.

12,843. "Electric bell." H. E. Friese. Dated July 17th.

12,846. "Improvements in portable electrical safety lamps." J. Glasmachers and C. Müller. Dated July 17th. (Complete.)

12,855. "Improvements relating to the manufacture of bulbs for electric incandescent lamps." C. Junge. (The Oberlausitzer Glashüttenwerke Otto Hirsch, Germany.) Dated July 17th.

12,874. "Improvements in and relating to telephonic apparatus." G. Blanck. Dated July 17th.

12,876. "An improved trolley for overhead electric traction." E. G. Johnson, F. D. Palmer, and C. Coenen. Dated July 17th. (Complete.)

12,893. "Underground wires for transmitting electric energy." T. Rosati. Dated July 17th. (Complete.)

12,922. "Improvements in electrical tramways and trains." Sir W. H. Preece, K.C.B., and P. Cardew. Dated July 18th.

12,944. "An improved electrical switch." H. F. Clayton, T. Bell, and S. S. Berry. Dated July 18th.

12,950. "Improvements in voltameters for the electrolysis of water, system Garuti." P. Garuti and R. Pompili. Dated July 18th. (Complete.)

12,954. "Improvements relating to connections for concentric or single cables." G. D. Dauncey and C. Davies. Dated July 18th.

12,971. "Improvements in electric switches." D. R. Bruce. Dated July 18th. (Complete.)

12,972. "Automatic booster in connection with a multiple wire system." J. S. Highfield. Dated July 18th.

12,973. "An indicator for high electrical tensions." Siemens Brothers and Co., Limited. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated July 18th.

12,977. "Improved electric battery." P. E. Francken. Dated July 18th.

12,992. "Improvements in or connected with electric traction." W. J. Davy. Dated July 18th.

13,010. "Improvements in high voltage fuses." W. Jamieson and The Scottish Wireless Electric Syndicate, Limited. Dated July 19th.

13,014. "Improvements in and connected with fuses or cut-outs for high voltage circuits." H. Oppenheimer. (Actiengesellschaft Mix & Genest, Germany.) Dated July 19th.

13,015. "Improvements inland connected with insulated bases for switches." H. Oppenheimer. (Actiengesellschaft Mix & Genest, Germany.) Dated July 19th.

13,020. "Apparatus for generating dynamical electricity by means of the direct influence of steam." E. van Haanen. Dated July 19th.

13,021. "Improvements in electric ignition devices for internal explosion engines. E. Gardner, T. H. Gardner, and L. Gardner. Dated July 19th.

13,024. "Improved means for starting and stopping electro-motors." A. E. Segnitz. Dated July 19th.

13,031. "An improvement in or connected with laminated electric switches." A. Reame and C. Wokes. Dated July 19th.

13,035. "Improvements in or connected with apparatus for electrically igniting miners' safety lamps." A. E. Best. Dated July 19th.

13,036. "Improvements in dynamo-electric machines and electric motors." H. F. Joel. Dated July 19th.

13,044. "An improvement in electric railways in which transformers are carried on the train." Siemens Bros. & Co., Ltd. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated July 19th. (Complete.)

13,048. "Improvements in and relating to means for controlling the speed of electro motors." W. B. Elliot and J. W. Eskholme. Dated July 19th. (Complete.

13,049. "Improvements in maximum demand electricity indicators." E. Schattner. Dated July 19th.

13,061. "Improvements in means for grinding and truing up dynamo commutators and the like." P. J. Purdy. Dated July 20th.

13,085. "Improvements in the method of and means for sounding alarms on electric tram and motor cars." A. Parietti and A. R. Durante. Dated July 20th.

13,095. "Storage battery electrode." R. McRae and H. C. McRae. Dated July 20th. (Complete.)

13,102. "Improvements in and relating to electrical conductors." W. A. Phillips and C. E. Kent. Dated July 20th.

13,103. "A new or improved method and means for fire-proofing insulated wires and cables." W. A. Phillips and C. E. Kent. Dated July 20th.

13,104. "Improvements in means for covering wires and cables." W. A. Phillips and C. E. Kent. Dated July 20th.

13,105. "Improvements relating to the covering of electrical conductors." W. A. Phillips and C. E. Kent. Dated July 20th.

13,106. "Improvements in safety devices for electric interlocking or block signalling apparatus." F. T. Hollins. Dated July 20th.

13,125. "Improvements in automatic cut-outs or combined cut-out and shunt switches for overhead trolley wires for electric traction, overhead electric cables, or the like." R. Hacking. Dated July 20th.

* A notable exception to this disposition is the arrangement that has been used for many years by the Swedish firm of Wenström for their small single-phase motors, which have the starting coils "staggered" from the position indicated here.

13,134. "Improvements in and relating to electric arc lamps." A. B. Walton. (Date applied for under Patents, &c., Act, 1883, Sec. 103, December 21st, 1899, being date of application in United States.) Dated July 20th. (Complete.)

13,143. "Improvements in telephonic signalling apparatus, applicable also to other purposes." The Thomson-Davis Telephone System, Limited, and A. T. M. Thomson. Dated July 20th.

13,184. "The Elland electric railway fog signal." A. Brook. Dated July 21st.

13,195. "Improvements in electrolytic apparatus for the production of caustic soda." G. H. Smith. Dated July 21st.

13,198. "Improvements in electric traction." B. Crucellier. Dated July 21st. (Complete.)

13,199. "Improvements in and relating to Röntgen ray and like apparatus." F. L. Muirhead and R. H. Edgar. Dated July 21st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

18,057. "Improvements in or relating to electric lamps." L. Horwitz. Dated August 22nd, 1898. Relates to portable electric lamps. A portable secondary battery lamp, especially for miners' use, is provided with two incandescent lamps, the second of which automatically comes into operation if the main lamp fails. The main lampholder is supported adjustably by a ball joint between the sides of a hand-loop. A parabolic reflector is screwed on the holder so that the filament is at its centre, and locked by a nut. Covers for the lamps and for the front of the box are made air tight and secured by seals. The battery carries two terminal strips, which are held against connecting springs on a partition by a back spring; after recharging the battery it is replaced so as to reverse the direction of the current through the lamp and switches. A switch is movable over three contact plates by a handle passed through packing in the front, the first plate being unconnected, and the others respectively connected to the two lamps. The contact plates may be ridged, to retain the switch against the action of a spring. Connection between the second plate and the main lamp is made through an electro-magnet, which retains a spring-pressed armature so long as current passes, but if the main lamp fails, the armature is released and makes another contact, connecting the second lamp in circuit automatically. When the switch is on the unconnected plate, it holds the armature away from the back contact. The connections may be modified so that current supplied by the hand switch to either lamp passes through the electro-magnet; if one lamp fails, the armature falls back and supplies the other, but this contact is made intermittent by the action of the electro-magnet and the light flickers. In another modification, the armature when attracted moves an additional spring, thus breaking a connection between the second and third contacts of the hand switch; when either lamp supplied by the hand switch fails, the other is connected automatically. 6 claims.

18,156. "Improvements in the manufacture of electrical resistances." A. Vogt. Dated August 23rd, 1898. A mixture of a conductor and a non-conductor, finely divided, is made into a paste with water, cast or moulded to any desired forms, dried, embedded in powdered carbon in a closed or nearly closed receptacle and heated to a high temperature. The conductor may be a mixture of carbon and a metallic powder, in order that the resistance may vary little with temperature. The metal may be produced from a silicide or other compound added to the mixture, and the carbon from tar, sugar, cellulose, or other carbonaceous material; when tar or asphalt is used, it is mixed hot with the non-conductor. The non-conducting material may be any artificial stone, magnesia, or other like material. Specification No. 15,238, A.D. 1897, is referred to. The resistances are applicable for regulating current, and heating by electricity. 3 claims.

18,172. "Improvements in continuous current electric motors or generators of ironclad or enclosed type." H. W. Wilson. Dated August 24th, 1898. Continuous current motors and generators of the ironclad or enclosed type are constructed as follows:—The main body casting consists of a cylindrical box made in two parts, the upper of which constitutes a lid or cover. The lower part supports the field-magnet core provided with pole-pieces which are preferably removable. Ventilating openings are formed through the upper and lower pole-faces, and extend to the outside of the machine. Cylindrical projections from the ends of the machine support the bearings and enclose the commutator or commutators, to which access may be obtained through doors. These projecting parts are bored concentrically with the pole-faces, but eccentrically with the main body of the machine. The bearings are provided with circular flanges, formed with ventilating openings. A modification is described, in which the armature and field core are inverted. 3 claims.

18,213. "Improvements in electric motors and in their application to motor carriages." The Britannia Motor Carriage Company, Limited, and J. Smith. Dated August 24th, 1898. Relates to the construction of electric motors and their application to motor carriages, and particularly to the means employed for transmitting motion from the armature of the motor to the driving shaft and wheels of the carriage. The motor is constructed with stationary field magnets secured to one of the side plates of a casing or frame, provided with sleeve-like extensions through which passes the shaft. The armature is mounted loosely on the shaft, and carries a sprocket pinion from which motion is transmitted through a sprocket-wheel spur pinion, and spur-wheel, to a box containing compensating bevel gear. Rotation of the box on the one hand drives the axle and one driving wheel, and on the other hand, the second driving wheel. This box may also constitute a brake drum. The underframing of the carriage is supported by collars on the sleeves, these collars being provided with guide-rods on which are arranged spring interposed between the collars and the brackets. 5 claims.

18,231. "Electrical heating appliances formed of artificial stone." J. F. Bachmann, A. Vogt, C. C. Weiner, A. Konig, Dr. J. Kirchner, and Dr. A. Jorg. Dated August 24th, 1898. Resistances made by moulding and firing mixtures of carbon or divided metal with non-conductors such as clay or porcelain, as described in Specification No. 15,238, A.D. 1897, and No. 18,156, A.D. 1898, are used in two forms for heating bodies from within and without, respectively. The resistances are insulated by air, or by glazing or enamelling, or by heating electrically to whiteness so that the carbon on the surface burns out, after which the surface is coated with solution of aluminium sulphate, or other suitable material, and heated. A soldering iron is described which contains the cylindrical resistance provided with connecting rings on its ends, and with a metal screw for short-circuiting more or less of it to regulate the temperature. Flat-irons, froning rollers, and singeing apparatus may be heated similarly by enclosed tubular resistances. The insulating coating may be on the inner surface of the iron. Tubular resistances with end connections may also be used for heating curling tongs placed in them, or liquids passed through them. In other apparatus, such as the crucible, a vessel is made of the resistant material, with grooves to receive conducting wires before the glazing, and these can be connected in various ways by switches to regulate the heat produced by current passing through the material from one or more wires to others. The resistant body may be surrounded by an air jacket, or non-conducting material, to reduce loss of heat. In place of the wires the surfaces of the resistant body may be coated with metal, and the coatings connected by spring clips or otherwise to supply conductors so that the current passes directly through the thickness of the resistant material. Heaters to be placed in liquids, boilers, air-heating, and other stoves, floors, walls, and ceilings of buildings, and hot-plates, baking dishes, and other cooking apparatus may be constructed similarly. 3 claims.

18,232. "Electrical resistances of artificial stone composition." J. F. Bachmann, A Vogt, C. C. Weiner, A. Konig, Dr. J. Kirchner, and Dr. A. Jorg. Dated August 24th, 1898. Resistances of moulded and fired compositions containing conducting and non-conducting materials such as are described in Specifications No. 15,238, A.D. 1197, and No. 18,156, A.D. 1898, are made adjustable, for various purposes, by varying the connected length or cross-section of the resistances, or by connecting parts of differing conductivities. In one form, resistant straight tubes or bars of various sections are short-circuited more or less by screws, nuts, clips, or slides, or by permanent connections with plug blocks, or with an inclined row of wires which which may be successively connected by raising a bath of mercury. Such resistances may be made with differing specific resistances at different parts, and with ribs or channels to convey fluid to cool them. Circular resistances may be connected by movable arms. In such a resistance arranged to control between outer and inner rings of resistant metal is a ring containing two conducting segments, which are connected to the ends of the field-magnet winding of the motor. The movable arm makes contact at opposite ends with the outer and intermediate rings, and its longer arm carries an insulated spring connecting the intermediate and inner rings. Connections being suitably made, the turning of the arm to right or left causes the motor to run in either direction. 2 claims.

18,261. "Improvement in relays for use on telegraph cable and other lines." S. G. Brown. Dated August 25th, 1898. Relays for cable and other telegraph work. A coil connected to line and mounted in the field of a magnet is either connected by two threads or by a rigid attachment to a second coil arranged in the field of an alternating current magnet. The coils of the alternating current magnet and the coil are connected respectively to a commutator and a rectifier. The commutator is also in circuit with a battery, and the rectifier is connected by lines to the receiver or the next section of the cable, &c. In modified arrangements a single coil may convey both the line and induced currents, an induction coil being used with the battery as the exciting source of the magnet and a synchronizing meter driving the rectifier. Condensers and inductance coils are inserted where necessary. In further modifications, a third suspended coil may be employed, or stretched wires connected by a paper strip may be substituted for the suspended coils. 2 claims.

18,246. "Improvements in systems of electrical distribution and regulation." S. G. Lamme. Dated September 9th, 1898. (Date claimed under Patents, &c., Act, 1883, Section 103, February 10th, 1898.) Relates to the transformation of direct currents to alternating currents by means of a rotary transformer or converter. In order that the speed, or rate of alternation, may be approximately constant irrespective of changes in the inductive load, a small direct current generator is employed for exciting the field magnets of the rotary converter. The generator supplies direct current to the rotary converter, the field magnet of which is excited by a direct current generator. This generator is driven by an induction motor or it may be driven directly from the rotary converter. 3 claims.

18,256. "Improvements in the covers or lids of sewer, gas, electric and telephone supply shafts, holes, gullies, and the like, and in their supporting frameworks." J. Price and J. Johnson. Dated September 9th, 1898. The cover is made with quadrantal trunnions which enter recesses in the frame, which when raised a space is left between the back of the cover and the frame for the passage of dirt, &c The cover is locked in its raised position by a sliding bolt which engages with a projection on the frame. In the closed position, projections engage with an undercut recess. Rubber packing may be placed on the stops for the cover. The Provisional Specification states that the trunnions may be formed of rollers mounted on pins. 5 claims.

18,264. "Improvements in electric motors." C. Canto. Dated September 9th, 1898. Relates to quantity meters. A train of gearing carried in a frame and provided with counting dials, a fan, and a ratchet wheel, is acted on by a weighted horizontal pawl lever engaging the ratchet. The main circuit of the lever includes an electro-magnet which on current passing attracts a spring-supported armature so that this releases the fan and allows the gearing to be driven by the weighted lever. The fan spindle carries a disc within stationary coils, one winding of which carries a constant current, being connected between the mains to retard magnetically the disc and gearing to a definite extent. Other parts of the coils are in the main circuit, so that the current in this diminishes the retardation. The gear frame is supported upon pivots by a spring; when the weighted lever descends so far as to rest on a fixed support, the frame being relieved of its weight is turned by the spring, ringing a bell, and raising a switch which opens the main circuit. The meter is started again by raising the weight. A spring may be used instead of the weight to operate the pawl lever. 3 claims.

18,265. "Improvements in coin-freed mechanism for electric meters." C. Canto. Dated September 9th, 1898. A weight motor with a train of wheels ending in a flyer drives an armature in a field formed by the main lead and a shunt oppositely wound, so that the time in which the weight runs down under the control of the flyer only is varied according to the differential retarding action of the currents on the armature. Indices on the arbor of the train travel round dials graduated to quantity or energy. This meter with the flyer is hinged to a stationary bracket, and is pulled against gravity by a spring, but the driving weight, acting through a ratchet lever, holds the meter down on a bed-plate till the lever touches the same, and the weight consequently is no longer effective. In accordance with the two positions of the meter, the circuit is made or broken between two terminal screws by a bridge extending from the meter. If no current is being taken, the meter is locked by an electro-magnetic and spring detent. The bridge for the circuit is attached to the meter by a butt hinge, so that it cannot complete the circuit unless a finger erected by a spring is tripped by a lever on which the coin falls. 2 claims.

18,313. "Improvements in shade and lampholders for incandescent electric lamps." S. H. Smith and J. H. Smith. Dated September 10th, 1898. Relates to holders for incandescent lamps. A socket for a bayonet-capped lamp is detachably connected by slots with pins in a cover, and is made with projections to engage in recesses in the insulating body, which is also held by these pins. The socket is provided with a collar to support a spring and sliding sleeve, by which a shade can be held against the edge of the cover. In a modification, the collar is replaced by a sleeve, which is secured detachably by slots and pins on the socket, and which contains the spring to hold up a shade-supporting ring. 3 claims.

18,337. "Electric apparatus for regulating clocks." R. J. Rudd. Dated September 21st, 1898. Occasional momentary electric currents from a standard timekeeper are employed to shift a lever pivoted on a bracket so as to alter the effective length of the pendulum spring by means of the curb pins in case the two clocks are not exactly synchronous. The action is brought about as follows:—From a joint or a regulating-lever a rod hangs down through a loop and against a supporting friction pawl under a spring. A snail turning with the seconds hand determines the amount of movement given to the regulating-lever, because it limits the lift of a lever which is thrown up against the hanging rod when the armature of the electro-magnet is attracted. The armature kicks a bell crank on the same pivot as the lever and the bell crank affects the lever through a C spring. In a modification, the regulating lever affects the spring of an auxiliary pendulum which is connected by a spring to the main pendulum. The snail may be replaced by a pin-wheel, and the cam be formed on the contacting lever. A hand lever is provided for setting the pin-wheel after setting the hands. 4 claims.

18,418. "Improvements in telephone installations." F. O. Prendek, F. Kolliseher, and A. Landmann. Dated September 18th, 1898. A system of loud-speaking telephony for use when a number of receivers have to be actuated by one or two transmitters, for long distance or submarine telegraphy. The induction coils used have the primary wound in a number of sections on the various parts of a closed magnetic ring, or the various coils of the primary may be in superposed layers. The secondary consists of a single coil running throughout the length of the ring or core. An arrangement is shown with one microphone connected on one side to one primary and battery, and on the other to the second half of the battery and the other primary. The secondary may either lead to the receivers, which are arranged in series, or may be in series with a battery and the primary of a second induction coil, the secondary of which is connected to the receivers. In a further arrangement, the receivers in the secondary of the first induction coil excite microphones and batteries in the primary circuits of other distributing induction coils. The receivers are described as having cut-out switches. The receiving induction coils may have short secondary coils for actuating ordinary receivers. 6 claims.

18,600. "An improvement in connections for electrical fuses." T. McEwan. Dated September 14th, 1898. The fuse wire is clamped in position by cams or discs eccentrically pivoted on the terminal. 1 claim.